TELEDYNE LECROY
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Summit T24
PCI Express
Multi-Lane Protocol Analyzer
User Manual

For PCIe Protocol Suite software version 7.36

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Teledyne LeCroy Protocol Solutions Group

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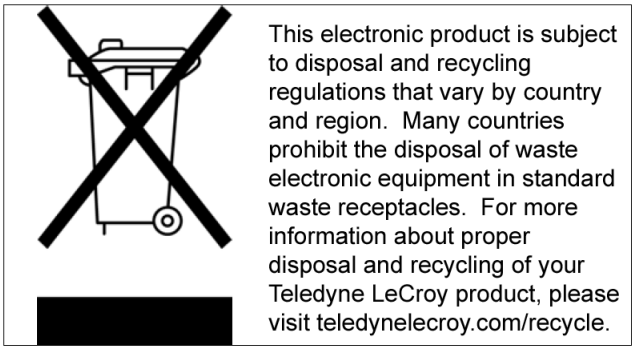
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Contents

Chapter 1: Overview 1

1.1 PCIe Protocol Suite Analyzer Hardware and Software 1

1.1.1 CATC Trace Software 2

1.1.2 Summit T24 Analyzer 2

1.1.3 Other Documents 4

Chapter 2: Hardware Description 5

2.1 System Components 5

2.2 Host Machine Requirements 5

2.3 Summit T24 Front Panel Description 5

2.4 Summit T24 Rear Panel Description 6

Chapter 3: Installation and Setup 7

3.1 Installing the PCIe Protocol Suite Software 7

3.2 Setting Up the Summit T24 Analyzer using a USB Connection 9

3.3 Networking an Analyzer 9

3.3.1 Setup for IP LAN Use 9

3.4 Interposers and Probes 10

3.5 Using Interposers 10

3.5.1 Gen2 Passive Interposer 10

3.6 Using Probes 12

3.6.1 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 MidBus Probe 12

3.6.2 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Multi-lead Probe for x1 and x4 14

3.6.3 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Multi-lead Probe for x4 15

Chapter 4: Software Overview 17
4.1 The PCIe Protocol Suite Software 17
4.2 Application Layout 18
4.3 Using the Toolbar 18
4.4 Multi-Segment Toolbar 21
4.4.1 Toolbar Hide Buttons 21
4.5 Using the Menus 24
4.5.1 File Menu 24
4.5.2 Setup Menu 30
4.5.3 Record Menu 30
4.5.4 Report Menu 31
4.5.5 Search Menu 32
4.5.6 Quick Search Feature 34
4.5.7 View Menu 35
4.5.8 Tools Menu 36
4.5.9 Window Menu 37
4.5.10 Help Menu 37
4.6 Dashboard View 37
4.7 Tool Tips 39
4.8 Keyboard Shortcuts 39
4.9 Status Bar 40
4.9.1 Recording Progress Bar 40
4.9.2 Recording Status 41
4.9.3 Recording Activity 41
4.9.4 Search Direction Indicator 42
4.10 Making a PCI Express Recording 42
4.10.1 Stopping a Recording 43
4.10.2 Saving a Recording 44
4.11 PCIe Protocol Suite Files 44
4.11.1 CATC Trace Files 44
4.11.2 Recording Options Files 44
4.11.3 Display Options Files 44
4.12 Saving CATC Trace Files 44
4.12.1 Using the Save As Function 45
4.12.2 Saving a Portion of a CATC Trace 46
4.12.3 Trace File Structure 47
4.13 Exporting a CATC Trace File 47
4.14 Printing Data Files 48
4.15 Analyzer Chat Window 49

4.15.1 CrossSync Control Panel 50

Chapter 5: Recording Options 53
5.1 Recording Overview 53
5.2 General Tab 53
5.3 Recording Options-General Tab 54
5.4 Simple and Advanced Mode 55
5.5 Trace Filename and Path 55
5.6 Saving and Loading Previously Saved Recording Options 56
5.6.1 Setting Default Recording Options 56
5.6.2 Loading Recording Options 56
5.6.3 Saving Recording Options 57
5.7 Recording Type 57
5.7.1 Snapshot 58
5.7.2 Manual Trigger 58
5.7.3 Event Trigger 58
5.8 Buffer Size 58
5.9 Upload Size 59
5.10 Misc 59
5.11 Recording Mode 60
5.11.1 Protocol Recording 60
5.11.2 BitTracer Recording 60
5.12 Trigger Position 60
5.12.1 Viewing Legacy Multi-Segmented CATC Traces 61
5.13 Link Settings 61
5.13.1 Speed 62
5.13.2 Link Width 63
5.13.3 Upstream and Downstream 63
5.13.4 Reference Clock 63
5.13.5 Disable Descrambling 63
5.13.6 Auto-Configure Lane Polarity 64
5.13.7 Ignore Idle Errors 64
5.13.8 Swizzling Config... 64
5.14 Triggering 65
5.14.1 Triggering On (Simple Mode) 66
5.14.2 Triggering On (Advanced Mode) 67
5.15 Navigating Recording Rules 68
5.15.1 Toolbar 68
5.15.2 Available Events Area 68

5.15.3 Main Display Area....68
5.15.4 Recording Rules Buttons....69
5.16 Recording Rules Overview....69
5.16.1 Defining Recording Rules....69
5.17 Resources....72
5.17.1 Packet Match Resource....72
5.17.2 Basic Resource....75
5.18 Global State and Sequence States....77
5.18.1 Global State....77
5.18.2 Sequence State....79
5.19 Recording Rules Events....80
5.20 Properties Dialog Boxes for Events....82
5.20.1 Accessing the Properties Dialog....82
5.20.2 Event Properties Dialog Box Features....82
5.20.3 Link State Dialog....83
5.20.4 Ordered Set Properties Dialog....84
5.20.5 Error Properties Dialog....84
5.20.6 DLLP Packet Properties Dialog....85
5.20.7 TLP Header Properties Dialog....86
5.20.8 TLP Prefix Properties Dialog....86
5.20.9 AHCI Register Properties Dialog....87
5.20.10 NVME Register Properties Dialog....88
5.20.11 PQI Register Properties Dialog....89
5.20.12 SOP IU Type Properties Dialog....90
5.20.13 Actions Properties Dialog....90
5.21 Filter Out....92
5.22 Filter In....93
5.23 Triggering Configuration on a per Lane Basis....98
5.24 Counter....106
5.24.1 How to Set a Counter....108
5.24.2 How to Increment or Reset a Counter....108
5.24.3 Changing the Value of the Counter....109
5.24.4 Deleting a Counter....110
5.25 Timer....110
5.25.1 How to Set a Timer....112
5.25.2 How to Start or Reset a Timer....112
5.25.3 Changing the Value of the Timer....113
5.25.4 Deleting a Timer....114
5.26 Channel....114
5.27 Probe Settings....115

5.27.1 Save 119
5.27.2 Load 120

Chapter 6: Reading CATC Traces 121
6.1 Viewing PCI Express CATC Traces 121
6.2 Expand and Collapse Data Fields 121
6.3 Resizing Cells 122
6.4 Pop-up Menus 122
6.5 View Data Block 122
6.6 Show Raw 10b Codes 123
6.7 Show Header Fields 124
6.8 Packet Cell Popup Menus 125
6.8.1 Set Start Quick Timing Marker 125
6.8.2 Set End Quick Timing Marker 125
6.8.3 Delete All Quick Timing Marker 125
6.8.4 Packet Header R-> Cell Popup Menu 127
6.8.5 Packet Header G1 Cell Popup Menu 127
6.9 Set Marker 127
6.10 Edit or Clear Marker 129
6.11 Compressed CATC Trace View 129
6.12 Spreadsheet View 130
6.12.1 Columns 132
6.12.2 Detail View and Spreadsheet View 134
6.13 Decoding Traffic 135
6.13.1 Packet 135
6.13.2 Link 136
6.13.3 Split 136
6.13.4 NVMe 137
6.13.5 AHCI 146
6.13.6 ATA 147
6.13.7 PQI 149
6.13.8 SOP 150
6.13.9 SCSI 150

Chapter 7: Searching CATC Traces 151
7.1 CATC Trace Search Overview 151
7.2 Go to Trigger 151
7.3 Go to Selected Packet 151

7.4 Go to Packet 152
7.5 Go to Time 152
7.6 Go To Marker 152
7.6.1 Markers 153
7.6.2 Attaching Markers 156
7.6.3 Adding an Attachment 156
7.6.4 Recording an Audio File 157
7.6.5 Video Files Supported 157
7.6.6 Attachment Types and Visualization 157
7.6.7 Embedded Attachments to a Marker 157
7.6.8 Viewing Attachments of a Marker 158
7.6.9 Edit Marker 162
7.6.10 All Markers Window 163
7.7 CATC Walk Playlist 165
7.7.1 Playlist Functionality 165
7.7.2 Playback Window 166
7.8 Go To SCSI Menu 168
7.9 Go To Menu 168
7.10 Search Direction 169
7.11 Find 169
7.11.1 Event Groups 171
7.12 Search for the Next Packet Type 176
7.13 Quick Search Feature 177

Chapter 8: Display Options 181
8.1 Setting Display Options 181
8.2 Specifying General Display Options 182
8.2.1 Fonts 182
8.2.2 Configuration Name 182
8.2.3 Color, Format, and Hiding Options 182
8.2.4 Setting Field Colors 183
8.2.5 Changing Field Formats 185
8.2.6 Hiding Fields 186
8.2.7 Hiding Levels 186
8.3 Load a Previously Saved Display Options File 189
8.4 Saving Display Options 189

Chapter 9: BitTracer Recording 191
9.1 Enabling BitTracer Recording 191

9.2 Views Available for Captured Data 192
9.3 De-skewing Data 192
9.4 Data Display Formats 193
9.5 Color-Coding of BitTracer Contents 194
9.6 Report and Analysis Windows 194
9.7 Timing Measurements Bar 195
9.7.1 Markers Bar 195
9.8 Errors Bar 197
9.9 Symbols Bar 198
9.10 Events Bar 198
9.11 Packets Bar 199
9.12 Decoding Bar 200
9.13 Search 201
9.14 Link Configuration 202
9.15 Export of BitTracer Capture to CATC Trace Format 204
9.15.1 Exports Involving Multiple Logical Links on One Physical Link 204
9.15.2 Export To CSV Text 204
9.16 Compressing and Expanding the Data View 205
9.17 Opening and Saving BitTracer Captures 205

Chapter 10: Reports and Tools 207
10.1 Trace Information 208
10.2 Error Summary 209
10.2.1 Error Summary for Storage Protocols 210
10.2.2 Error Summary for Storage Protocols -- NVMe 212
10.3 Traffic Summary 213
10.3.1 Traffic Summary for Storage Protocols 214
10.3.2 Using the Traffic Summary Window to Search the CATC Trace 214
10.3.3 NVMe Queue Time Metrics 215
10.3.4 Traffic Summary Buttons 216
10.4 Bus Utilization 216
10.4.1 Bus Utilization Pop-up Menu 217
10.4.2 Bus Utilization Buttons 220
10.5 Link Tracker 222
10.5.1 Using the Link Tracker Window 223
10.5.2 Zooming In and Out 224
10.5.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths 224

10.5.4 Docking and Undocking the Window 225
10.5.5 Setting Markers 225
10.5.6 Calculating Time between DWORDs 225
10.5.7 Hiding Traffic 226
10.5.8 Link Tracker Buttons 226
10.6 Data Flow Window 227
10.7 Flow Control Tracking 229
10.8 Using the CATC Trace Navigator 230
10.8.1 Displaying the Navigator 230
10.8.2 Navigator Toolbar 231
10.8.3 Navigator Ranges 231
10.8.4 To Determine Current Position 232
10.8.5 To Reset Navigator Range 232
10.8.6 Navigator Panes 233
10.8.7 To Show/Hide Navigator Panes 234
10.8.8 Navigator Slider 234
10.8.9 CATC Trace Navigator Legend 234
10.8.10 Using the Legend to Show/Hide Navigator Panes 235
10.8.11 Using the Legend to Set the Priority of Information Display 235
10.9 Detail View 235
10.10 LTSSM Flow Graph 236
10.11 Packet Header Bar 237
10.12 Packet Data Window 238
10.13 Configuration Space View 239
10.14 Using Unit Metrics 240
10.15 Metrics Defined for Link Transactions 241
10.15.1 Metrics Defined for Split Transactions 241
10.16 Show Metrics in the CATC Trace Display 241
10.16.1 Collapsed Metrics Header Display 242
10.16.2 Metrics Tool Tip Display 242
10.16.3 Expanded Metrics Header Display 242
10.17 Show Metrics in the Traffic Summary Window 243
10.17.1 Reports at Split Transaction Level 243
10.17.2 Reports at the Link Transaction Level 244
10.18 Show Metrics in the Bus Utilization Window 245
10.18.1 Unit-Based Averaging 246
10.18.2 Bus Utilization Window Features 246
10.18.3 Split Transaction Level Graphs 246
10.18.4 Link Transaction Level Graphs 247
10.19 Real-Time Statistics Window 248

10.19.1 Real-Time Statistics Buttons 249
10.19.2 Real-Time Statistical Monitor Pop-up Menu 251
10.19.3 Real-Time Statistics Graph Areas 252
10.20 Memory I/O Space Editor 254
10.21 TC to VC Mapping 255
10.22 Timing and Bus Usage Calculations 256
10.22.1 Timing Calculator 256
10.22.2 Queue Utilization 258
10.22.3 Bus Utilization 259
10.22.4 Split Transaction Performance 259
10.22.5 Memory Writes Performance 259
10.23 PCIe SSD Base Address Mapping 261
10.23.1 NVMe PCIe SSD Device Configuration 261
10.23.2 AHCI PCIe SSD Device Configuration 266
10.23.3 PQI PCIe SSD Device Configuration 267
10.23.4 SOP and SCSI PCIe SSD Device Configuration 269
10.24 Running Verification Scripts 270
10.24.1 NVMe Performance: Doorbell Timing 273
10.25 Trace Expert 274
10.25.1 Performance Analysis 276
10.25.2 Trace Analysis Statistics 277
10.25.3 Error Reports 279
10.25.4 Trace File Information 281

Chapter 11: Updates and Licensing 285
11.1 Updating the Analyzer 285
11.2 License Keys 285
11.3 License Information 285

Appendix A: Configuration Space Decoding 287
12.1 Mandatory Definitions 287
12.2 Mandatory Module Functions 287
12.2.1 DecodeRegister() 288
12.2.2 GetSize() 288
12.3 Configuration Register Types 288
12.4 Primitives 288
12.4.1 GetRegisterField() 288
12.4.2 AddField() 289
12.4.3 AddSubField() 289

12.5 Helper File 290

Appendix B: Example of XML File Format for SSD Decodes.....291

Appendix C: China Restriction of Hazardous Substances Table.....293

Appendix D: How to Contact Teledyne LeCroy.....295

Chapter 1

Overview

Designed for developers and validators, the Teledyne LeCroy Summit T24™ is a Gen1/ Gen2 PCI Express advanced verification system.

By leveraging years of experience in protocol analysis tools for emerging markets, Summit T24 blends sophisticated functionality with practical features to speed the development of PCI Express™ IP cores, semiconductors, bridges, switches, add-in boards, and systems.

1.1 PCIe Protocol Suite Analyzer Hardware and Software

Features and Benefits

Summit T24 Analyzer has these features and benefits:

Features	Benefits
Powerful and Intuitive CATC Trace™ Analysis Software	Faster interpretation and debug of PCI Express traffic with color-coded, clearly labeled protocol elements in a graphical display.
Extensive Decoding	Complete, accurate and reliable decoding of TLPs (Transaction Layer Packets), DLLPs (Data Link Layer Packets), NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions and all PCI Express Primitives.
Intelligent Reporting	Quickly identify and track error rates and abnormal link or timing conditions. Display configuration space and protocol specification details.
Sophisticated Viewing	View Packet, Link, Split, NVMe, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol. Collapsible/expandable headers with Tool tip explanations make it easy to navigate and interpret packet contents, headers, and commands. View packets, transactions of TLPs and DLLPs in classic CATC Trace™ format or in raw bit stream for deeper analysis.
2 GB Recording Capacity, 1 GB in each direction	Capture long recording sessions for analysis and problem solving.

Flexible Host Interface	USB 2.0
Downloadable CATC Trace Viewer	Share and annotate CATC Trace recordings within a development team. Freely distributable PCIe Protocol Suite software enables collaborative analysis across sites and time zones.
Bidirectional x1-x4, 2.5 GBps to 5.0 GBps recording support	Accurate and non-intrusive collection of PCI Express CATC Trace data.
Field-upgradeable firmware and recording engine	Upgrades available for download direct from the Teledyne LeCroy website.
Flexible probing options	Supports a variety of probing options including slot interposers, MidBus probes and speciality probes. Gen2 MidBus probe Gen2 multi-lead probe Gen2 passive interposer Gen2 active interposer
External interface for probing and monitoring auxiliary digital signals	Enables cross triggering between other test instruments.
Dword to Transaction Level Viewer	View Dwords, Packet, Link, Split, NVMe, PQI, AHCI ATA, SOP and SCSI command transaction levels of the PCI Express protocol.

1.1.1 CATC Trace Software

Summit T24 utilizes the CATC Trace™ to assist users in analyzing how PCI Express components work together, diagnose problems, and test for interoperability and standards compliance.

The CATC Trace is a powerful and intuitive expert software system embedding detailed knowledge of the protocol hierarchy and intricacies, as defined in the protocol specification. The software allows the user to control the Analyzer and set specific real-time triggering and filtering conditions. The CATC Trace utilizes a Windows-based graphical display that has been optimized for fast and easy navigation through a captured traffic session. Users are alerted as violations are detected at all levels of the protocol layering and can easily drill down on areas of interest or collapse and hide fields that are not relevant.

1.1.2 Summit T24 Analyzer

The Teledyne LeCroy Summit T24 is Teledyne LeCroy's high performance PCI Express analyzer for customers in server, workstation, desktop, graphics, storage and network card markets (see Figure 1.1 on page 3).

Figure 1.1: Summit T24 Analyzer

With advanced features such as data rates from 2.5 to 5.0 GBps, lane widths from x1 to x4, and 2 GB of memory, the Summit T24 provides unmatched capability and flexibility for developers and users of advanced PCI Express products.

As with other Teledyne LeCroy PCI Express analyzers, the Summit T24 leverages the intuitive and powerful CATC Trace analysis software system, embedding a deep understanding of the PCI Express protocol hierarchy and intricacies. The colorful, intuitive and easy-to-use graphical display allows you to quickly capture and validate PCI Express product designs.

An optional BitTracer™ mode allows bytes to be recorded as they come across the link, allowing debugging of PHY layer problems and combining the features of a logic analyzer format with a protocol analyzer format.

Features

- **Powerful and Intuitive CATC Trace Analysis Software System**: The CATC Trace embeds deep understanding of the PCI Express protocol hierarchy and intricacies. This knowledge is presented in a colorful, intuitive and easy-to-use graphical display, allowing you to quickly capture and validate PCI Express product designs.
- **Protocol Hierarchical Viewing**: Displays Packet, Transaction, Split, NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions levels of the PCI Express protocol, with increased drill-down detail for PCI Express primitives, errors, payloads or individual packets.
- **Lane-Reversal Compatible**: Triggers, records, and displays PCI Express traffic logically, regardless of the physical configuration of the lanes.
- **Statistical and Error Reporting**: Provides a quick summary of the CATC Trace file to identify and track error rates and abnormal link or timing conditions.
- **BitTracer Recording Mode (optional)**: Records the bytes exactly as they come across the link, allowing debugging of PHY layer problems.
- **Auto Speed detection**: Follows link transitions through speed changes.
- **Field-upgradeable Firmware and Engine**: Positions you to receive the latest PCIe Protocol Suite enhancements and future additional capabilities. Allows field upgrades of all system types.

- **2-GB Data Buffer**: Capture long time windows for in-depth analysis and identification of erratic problems.
- **USB connectivity**: Allows connection by USB cable.
- **CrossSync Application:** The CrossSync application allows you to select analyzers for synchronization and manage the recording process.

1.1.3 Other Documents

For more information, refer to the following documents:

- Teledyne LeCroy Analyzers File-based Decoding Manual
- PCIe Protocol Suite/Trainer Automation Manual
- PCIe Protocol Suite VSE Manual
- CrossSync Control Panel User Manual

Chapter 2

Hardware Description

The PCI Express™ system features Summit Analyzers.

2.1 System Components

- Summit T24™ analyzer system
- DC Power Adaptor, 12 volts, and AC power cable
- USB cable
- PCIe Protocol Suite Software program DVD-ROM
- (optional) probes and interposers (see "Interposers and Probes" on page 10)

2.2 Host Machine Requirements

The Summit T24 connects to a host machine. Please consult the **readme** file on the installation DVD for the latest host machine requirements.

2.3 Summit T24 Front Panel Description

When powered on, the Summit T24 activates the user-accessible controls and LEDs on the front panel. Please see the *Summit T24 Quick Start* for an illustration of the front panel.

WARNING: Do not open the enclosure. There are no operator serviceable parts inside. Refer servicing to Teledyne LeCroy.

The controls and LEDs are:

- **Power LED**: Lights when power is On.
- **Status LED**: Displays the connection status of the link.
  - Red - Error condition. Try using the PCIe Protocol Suite application to clear the error. Please contact the factory if this does not work.
  - Green - Configuring system.
  - Purple - Waiting for connection.
  - Blue - Unit ready/connected.
- **Speed LEDs**: Indicates current speed the analyzer is using for the Upstream direction.
- **Upstream [3:0] LEDs**: Indicates which Upstream Lanes are currently showing activity.

- **Upstream [3:0] and Downstream [3:0] connector**: Connection to the probe for the capture of both upstream and downstream directions of the link.
- **Downstream [3:0] LEDs**: Indicates which Downstream Lanes are currently showing activity.
- **Speed LEDs**: Indicates current speed the analyzer is using for the Downstream direction.

2.4 Summit T24 Rear Panel Description

The Summit T24 rear panel contains:

- **USB Type B Host Machine Connector**: To connect the Analyzer to the host machine using a USB connection.
- **Sync /Data**: Allows multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another. This is also used for Trigger in and Trigger Out. The minimal pulse width for Trigger In is 20ns.
  - Trigger In has the following characteristics:
    - Trigger Input has a 1.5 k ohm pullup resistor to 3.3 volts.
    - Trigger Input also has a 50 ohm RC termination.
    - Threshold voltage for Trigger Input is 0.8 volts.
    - Voltages below 0.6 volts will be detected as low, voltages above 1.0 volts will be detected as high.
    - When Internal Triggering option is selected in the recording options, any edge of this signal will cause the analyzer to trigger.
  - Trigger Out has the following characteristics:
    - Trigger Output buffer is 3.3 volts. The buffer can drive up to 32 mA of current and meet VOH (2.5 V) and VOL (0.5 V) thresholds.
    - Trigger Output buffer can drive a 50 ohm DC load (such as scope input).
- **DC IN**: 12 V, 3 A
- **Power Switch (black)**: 1 = On and 0 = Off.

Chapter 3

Installation and Setup

The Summit T24™ is a standalone system.

You can begin PCI Express™ recordings after following the steps in this chapter.

3.1 Installing the PCIe Protocol Suite Software

Teledyne LeCroy's protocol software suite(s) are used to control all of our Analyzer products:

Teledyne LeCroy's various Protocol Software Suites are designed to be installed on a Microsoft® Windows® -based host machine and serve as the interface for the Analyzer system.

To install the Protocol Software Suite on the host machine:

1. Insert the Installation DVD-ROM into the DVD drive on the host machine.
2. The installation automatically starts setup, unless Auto Run is off. In that case, select the DVD-ROM from “My Computer” and click **Setup**.
3. After the warning to close all other programs and before starting the installation, the Install component selection opens.
4. Select components for installation.
5. Click **Next** to complete the installation.
6. To start the application, launch the PCIe Protocol Suite program from the Start menu: **Start > Programs > LeCroy > PCIe Protocol Suite > PCIe Protocol Suite**

The PCIe Protocol Suite program displays.

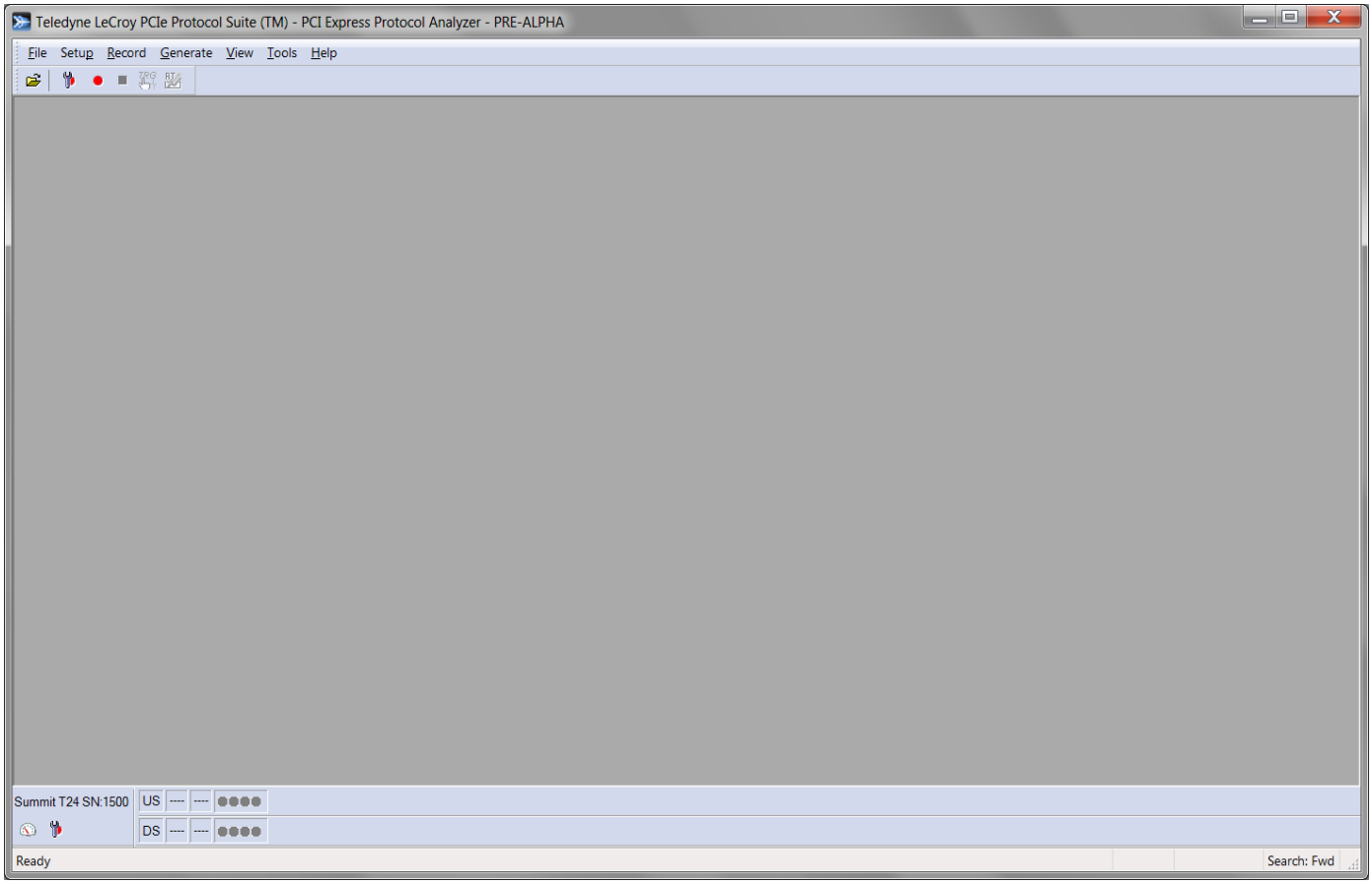

Teledyne LeCroy PCIe Protocol Suite (TM) - PCI Express Protocol Analyzer - PRE-ALPHA
File Setup Record Generate View Tools Help
Summit T24 SN:1500
US
DS
Ready
Search: Fwd

Figure 3.2: Teledyne LeCroy PCIe Protocol Suite Application

Note: The software may be used with or without the Analyzer. When used without an Analyzer attached to the computer, the program functions as a CATC Trace Viewer to view, analyze, and print captured traffic.

3.2 Setting Up the Summit T24 Analyzer using a USB Connection

To set up the Analyzer using a USB connection:

1. Connect the Analyzer to a 100-volt to 240-volt, 50 Hz to 60 Hz, 120 W power outlet using the provided power cord.
2. Connect the USB port to a USB port on the host machine using a USB cable.
3. Turn on the front power switch.

Note: At power-on, the Analyzer initializes and performs a self-diagnosis. The results are reflected by the Status LED.

4. Follow the Microsoft® Windows® on-screen Plug-and-Play instructions for the automatic installation of the Analyzer as a USB device on your analyzing host machine. (The required USB drivers are installed on your system by the PCIe Protocol Suite software installation.)

   Click **Finish** when you see the message that says “Windows has finished installing the software that your new hardware requires” and the file has been installed in your host machine.

3.3 Networking an Analyzer

PCIe Protocol Suite™ has a networking capability that allows users to run an Analyzer remotely over an IP-based LAN. Using the Network browse dialog, you can locate and connect to other host machines on the LAN, which, in turn, are connected to Analyzers. Through this connection, you can remotely control an Analyzer.

3.3.1 Setup for IP LAN Use

In order to connect to a remote Analyzer, the Analyzer must be attached to a host machine that is on the LAN. This host machine must have PCIe Protocol Suite installed.

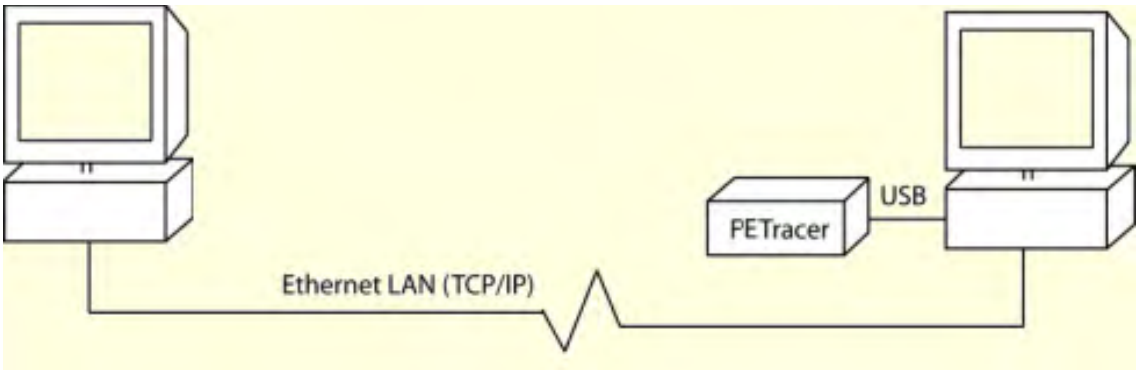


Figure 3.3: Analyzer Attached to a host machine on the LAN

Note: As of version PCIe Protocol Suite version 7.34, the software is able to access a Summit analyzer via VPN solutions that require explicit bindings to PPP adapters that they create.

3.4 Interposers and Probes

The Summit T24 works with Interposers and Probes. Some of them are listed below.

- **Gen2 MidBus Probe**: The Gen2 MidBus Probe is designed for use with the Summit T24 Analyzer and supports lane widths from x1 to x4 at data rates of 2.5 GT/s (Gen1) or 5.0 GT/s (Gen2).
- **Gen2 Multi-lead Probe**: The Gen2 Multi-lead Probe is designed for use with the Summit T24 Protocol Analyzer. The probe consists of 1 to 2 probe pods, which are connected to the analyzer using straight x4 iPass cables (for x4). Each probe pod supports up to 8 Flex Tips, with each Flex Tip connected via two coax cables.
- **Gen2 Passive Slot Interposer**: The Gen2 passive Slot Interposer is designed for use with the Summit T24 Analyzer and supports lane widths from x1 to x4 at data rates of 2.5 GT/s (Gen1) or 5.0 GT/s (Gen2). For lane widths up to x4, one iPass straight cable is required.
- **Gen2 Active Slot Interposer**: The Gen2 Active Slot Interposer when used on the Summit T24 will support lane widths from x1 to x4 at data rates of 2.5 GT/s (Gen1) or 5.0 GT/s (Gen2).

Please refer to the *Interposers and Probes for Teledyne LeCroy PCI Express Systems datasheet* at teledynelecroy.com for a comprehensive list.

The following sections describe how to set up probe systems.

3.5 Using Interposers

3.5.1 Gen2 Passive Interposer

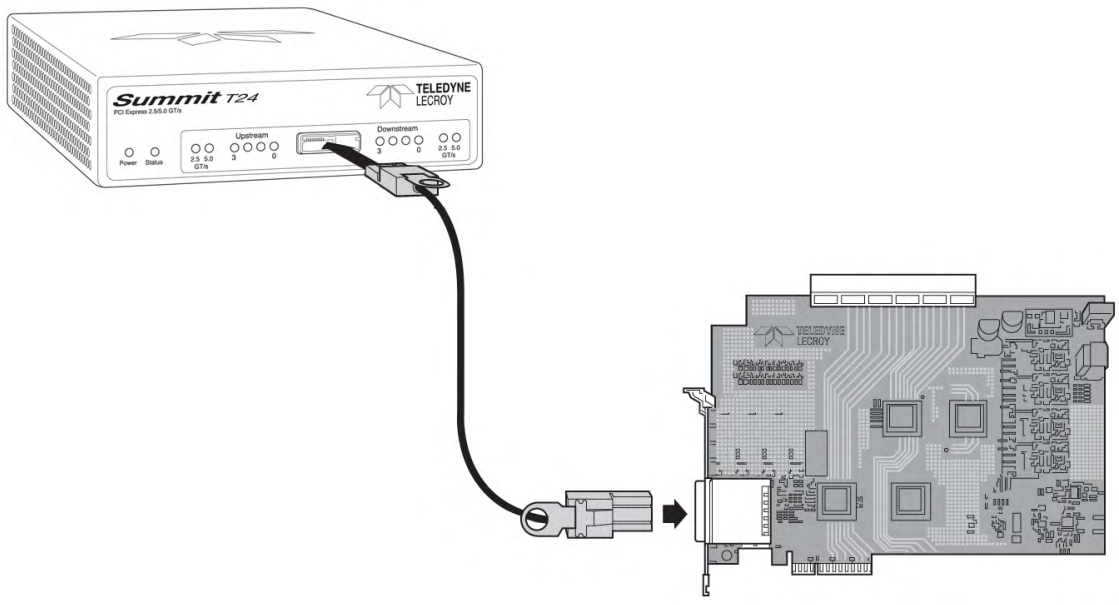


Figure 3.4: Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Active Interposer

Summit T24 Components

Summit T24 components used in the installation are:

- **iPass x4 to x8 Straight cable**: The cable supports four lanes from two directions but allows connection to x8 iPass connectors. The smaller x4 end plugs into the Summit T24 and the larger end plugs into the interposer
- **Summit T24 x4 Slot Gen2 Passive Interposer**: The slot Interposer provides the point of attachment for the Analyzer to the Device Under Test (DUT). The Interposer is designed to fit between a motherboard and one of its device cards - for example, a LAN card. The Interposer has three sets of connectors: a gold male connector that fits into a standard x4 up to x16 PCI Express slot on a motherboard, a PCIe female connector that accepts any PCI Express add in card. Although the PCIe female connector will accept up to x16 male connectors, only four lanes will be passed through the x4 interposer.

Note: If using X8 or X16 interposers, lane width reducers may be needed to analyze the link.

Installing the Gen2 Passive Interposer

To install the Interposer, perform the following steps.

1. Insert the gold male connector on the Interposer probe into a x4, x8 or x16 PCI Express slot in the motherboard. If a X1 link is required, use edge adaptor for x1.
2. Insert the PCI Express DUT into the Interposer's PCIe female device connector.
3. The slot Interposer is shipped from Teledyne LeCroy with a metal face plate for attachment to a PC case. If you are working with a motherboard that is not in a PC case, you may prefer to remove the metal face plate so the Interposer can sit flat with the motherboard. To remove the face plate, unscrew the two screws that hold it onto the Interposer

Power On Analyzer and then DUT

1. Power on the Summit T24 Analyzer.
2. Power on the DUT.
3. Open the PCIe Protocol Suite software on the host machine. The Analyzer is now ready for PCI Express traffic recording.

3.6 Using Probes

3.6.1 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 MidBus Probe

Note: Mid-bus probes require attachment-pad and reference-clock connections. For information about how to connect the attachment pad, reference clock, and cables in your system, see the *MidBus Probe Manual*.

Components

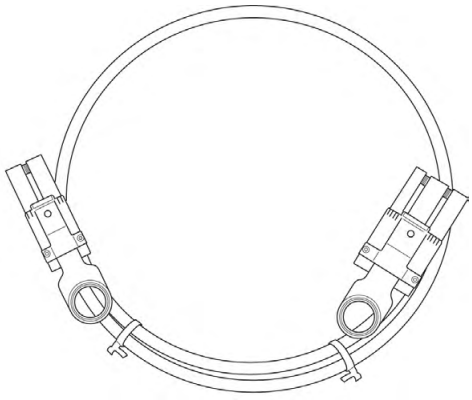


Figure 3.5: iPass x4 to x8 Straight Cable

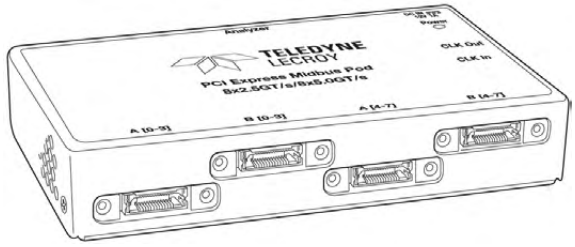


Figure 3.6: Gen2 Mid-bus Probe Pod for Summit T24

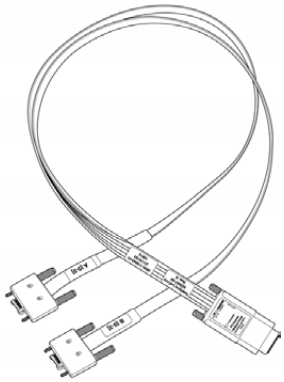


Figure 3.7: Half-size Gen2 Mid-bus Probe Cable and Header Assembly

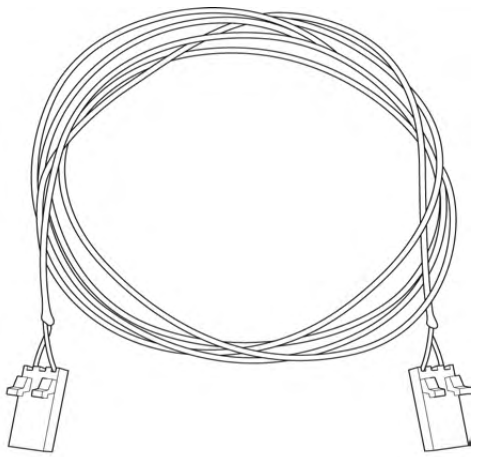


Figure 3.8: Clock Cable

Connections Overview for Gen2 MidBus Probe

Use a 1-pod setup.

Use the iPass x4 to x8 Straight cable to connect the probe data connectors on the Analyzer to the MidBus pod(s).

On the other side of the pod, connect the MidBus probe assembly.

Connect the header on the MidBus probe assembly to the MidBus footprint on the System Under Test (host platform/root complex). The following picture shows two midbus footprints, with one connected to the MidBus probe assembly.

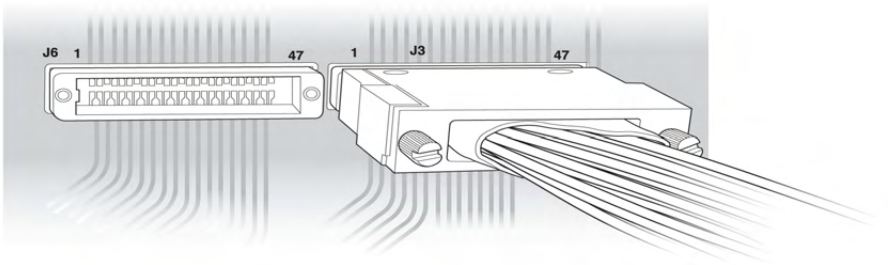


Figure 3.9: Connect MidBus Probe to MidBus Footprint

Connection Procedure

To connect the Summit T24 to the System Under Test (host platform/root complex):

1. Connect the MidBus pods to the Analyzer using the iPass x4 to x8 Straight cable.
2. Connect the MidBus probe assemblies to the MidBus pods.
3. Connect the MidBus probe assemblies to the MidBus footprints on the system under test.
4. Connect external reference clock signal to Mid-Bus External Clock In on Mid-Bus probe pod, using external reference clock cable.

3.6.2 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Multi-lead Probe for x1 and x4

Components

- ❑ iPass x4 to x8 Straight cable for x1 and x4 (see "iPass x4 to x8 Straight Cable" on page 12).
- ❑ 1 Multi-lead Probe Pod for x1 and x4

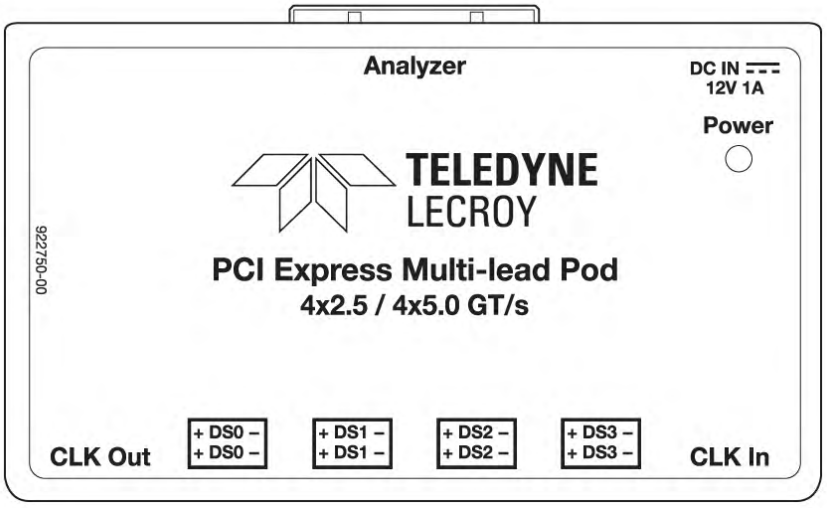


Figure 3.10: Multi-Lead Probe Pod

- ❑ Up to 16 MidBus Probe SSMP Cables, and up to 8 Flexible Leads, per pod

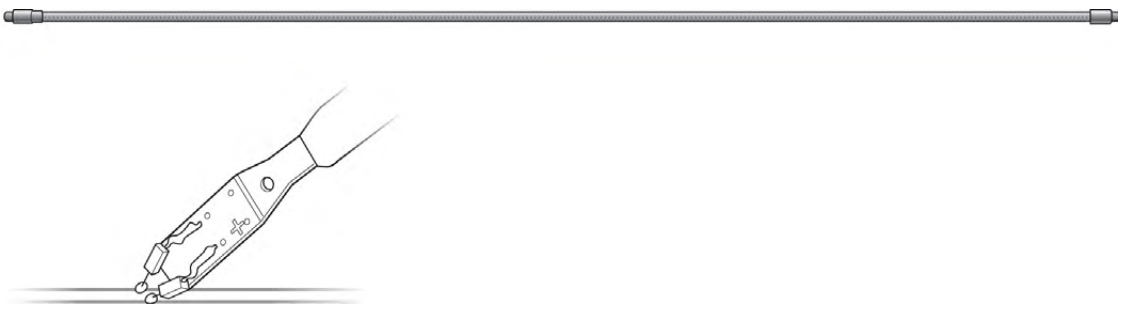


Figure 3.11: Midbus Probe SSMP Cables

- ❑ **1 Clock Cable** (see Figure 3.8 on page 13).

Connections for Gen2 Multi-lead Probe

Overview

Use a 1-pod setup.

For x1 or x4, use the iPass x4 to x8 Straight cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T24 to the System Under Test (host platform/root complex):

1. Connect the pods to the Analyzer using the iPass x4 to x8 Straight cable.
2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

3.6.3 Connecting the Summit T24 Analyzer to the Device Under Test Using a Gen2 Multi-lead Probe for x4

Components

- ❑ 1 iPass x4 to x8 Straight cable for x4

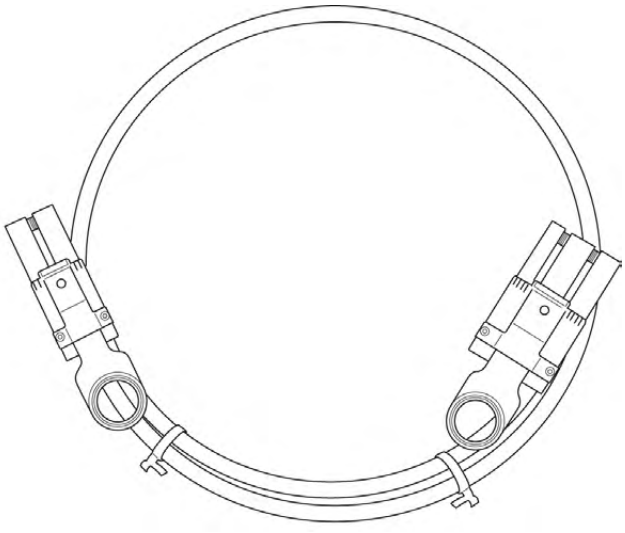


Figure 3.12: iPass x4 to x8 Straight cable

- ❑ 2 Multi-lead Probe pods for x4
  (See “1 Multi-lead Probe Pod for x1 and x4” on page 14).
- ❑ Up to 16 MidBus Probe SSMP Cables, and up to 8 Flexible Leads, per pod.
  (See Figure 3.10 on page 14).
- ❑ 1 Clock Cable (see Figure 3.7 on page 12).

Connections Overview for Gen2 Multi-lead Probe

Use a 1-pod setup.

For x4, use the straight iPass cable to connect the probe data connectors on the Analyzer to the pod(s).

On the other side of the pod, connect the flexible lead tips.

Connection Procedure

To connect Summit T24 to the system under test (host platform/root complex):

1. Connect the pods to the Analyzer using the straight iPass cables.

2. Connect the flexible lead tips to the pods using the SSMP cables.
3. Connect the lead tips to the system under test by soldering to the trace.

MicroD to CATC Sync Cable

The cable is used to synchronize the T24 with other Teledyne Lecroy systems. It also provides a way to supply input and output triggers. Use the two connectors shown below.

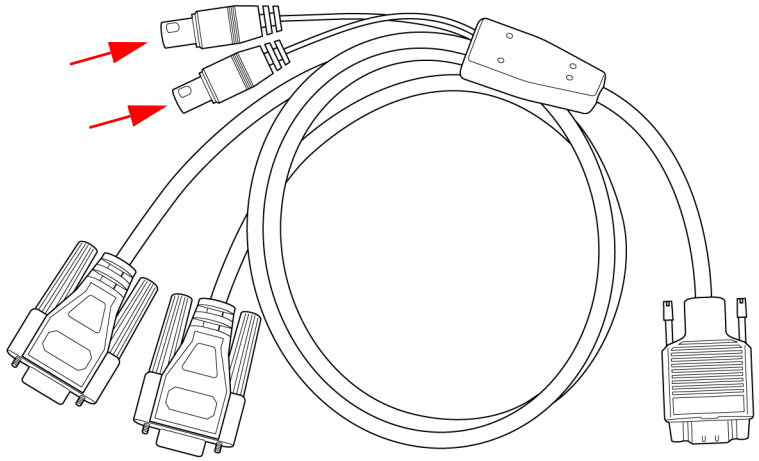


Figure 3.13: MicroD to CATC Sync Cable

Chapter 4

Software Overview

4.1 The PCIe Protocol Suite Software

The PCIe Protocol Suite™ software administers Analyzer platforms and handles all CATC Trace analysis and display. The core software is thus the same for all of Teledyne LeCroy's PCI Express products.

The software runs on a Windows® based host machine that is attached to the Analyzer via a USB 2.0 connection (USB 1.0 is also supported). PCIe Protocol Suite software can be used without the Analyzer as a CATC Trace viewer for viewing, analyzing and printing traces.

The PCIe Protocol Suite software operates on systems using Windows 8 (x86 and x64), Windows Server 2012 (x64), Windows 7 (x86 and x64), Windows Server 2008R2 (x64) and Windows XP (x86). The latest Service Pack available for the Windows OS in use is required. It is recommended that you use one of the supported 64-bit Windows versions listed above as they allow using more RAM than the 32-bit ones.

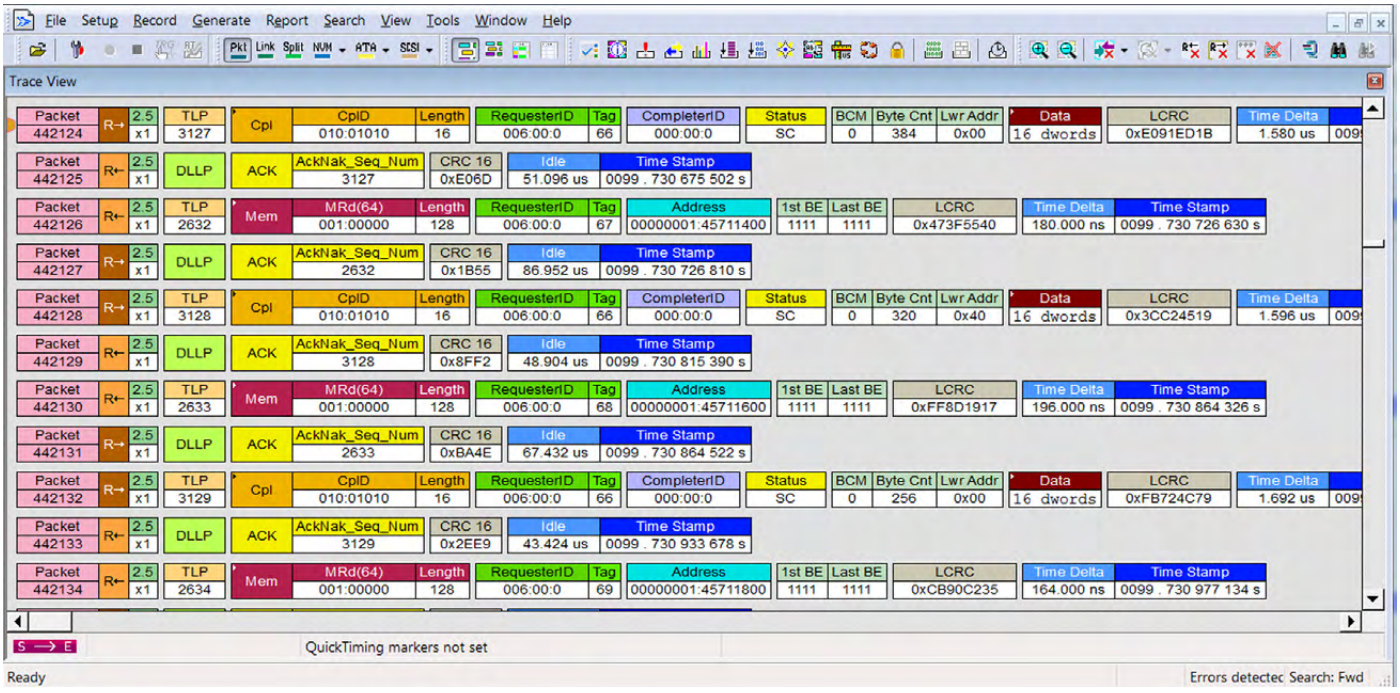

File Setup Record Generate Report Search View Tools Window Help
Trace View
Packet 442124 R→ 2.5 x1 TLP 3127 Cpl CplD 010:01010 Length 16 RequesterID 006:00:0 Tag 66 CompleterID 000:00:0 Status SC BCM 0 Byte Cnt 384 Lwr Addr 0x00 Data 16 dwords LCRC 0xE091ED1B Time Delta 1.580 us
Packet 442125 R← 2.5 x1 DLLP ACK AckNak_Seq_Num 3127 CRC 16 0xE06D Idle 51.096 us Time Stamp 0099 . 730 675 502 s
Packet 442126 R← 2.5 x1 TLP 2632 Mem MRd(64) 001:00000 Length 128 RequesterID 006:00:0 Tag 67 Address 00000001:45711400 1st BE 1111 Last BE 1111 LCRC 0x473F5540 Time Delta 180.000 ns Time Stamp 0099 . 730 726 630 s
Packet 442127 R← 2.5 x1 DLLP ACK AckNak_Seq_Num 2632 CRC 16 0x1B55 Idle 86.952 us Time Stamp 0099 . 730 726 810 s
Packet 442128 R→ 2.5 x1 TLP 3128 Cpl CplD 010:01010 Length 16 RequesterID 006:00:0 Tag 66 CompleterID 000:00:0 Status SC BCM 0 Byte Cnt 320 Lwr Addr 0x40 Data 16 dwords LCRC 0x3CC24519 Time Delta 1.596 us
Packet 442129 R← 2.5 x1 DLLP ACK AckNak_Seq_Num 3128 CRC 16 0x8FF2 Idle 48.904 us Time Stamp 0099 . 730 815 390 s
Packet 442130 R→ 2.5 x1 TLP 2633 Mem MRd(64) 001:00000 Length 128 RequesterID 006:00:0 Tag 68 Address 00000001:45711600 1st BE 1111 Last BE 1111 LCRC 0xFF8D1917 Time Delta 196.000 ns Time Stamp 0099 . 730 864 326 s
Packet 442131 R← 2.5 x1 DLLP ACK AckNak_Seq_Num 2633 CRC 16 0xBA4E Idle 67.432 us Time Stamp 0099 . 730 864 522 s
Packet 442132 R→ 2.5 x1 TLP 3129 Cpl CplD 010:01010 Length 16 RequesterID 006:00:0 Tag 66 CompleterID 000:00:0 Status SC BCM 0 Byte Cnt 256 Lwr Addr 0x00 Data 16 dwords LCRC 0xFB724C79 Time Delta 1.692 us
Packet 442133 R← 2.5 x1 DLLP ACK AckNak_Seq_Num 3129 CRC 16 0x2EE9 Idle 43.424 us Time Stamp 0099 . 730 933 678 s
Packet 442134 R← 2.5 x1 TLP 2634 Mem MRd(64) 001:00000 Length 128 RequesterID 006:00:0 Tag 69 Address 00000001:45711800 1st BE 1111 Last BE 1111 LCRC 0xCB90C235 Time Delta 164.000 ns Time Stamp 0099 . 730 977 134 s
S → E
QuickTiming markers not set
Ready
Errors detectec Search: Fwd

Figure 4.1: Sample of a CATC Trace

4.2 Application Layout

The PCIe Protocol Suite application contains the following components:

Title bar: The title bar is at the top of the application window and displays the CATC Trace file name or generation script name.

Menu bar: The menu bar is located below the title bar, by default. The menu bar can be moved by clicking a blank area of the bar and then dragging the menu to a new position. It can be docked in another part of the application window or moved outside of the window to become a floating menu.

Toolbar: The toolbar is composed of buttons that represent the commonly used commands. The toolbar divides into smaller toolbars that can be moved and docked in a new position or made to float outside of the window.

Display area: The display area is the main part of the application window in which CATC Traces are displayed.

Status bar: The status bar is located at the bottom of the application window. The left end of the status bar displays descriptions of buttons and menu items when the mouse is positioned over them. The right end of the bar shows the search direction.

4.3 Using the Toolbar

You can use the PCIe Protocol Suite application Toolbar as a shortcut to most of the operations supplied by the menus

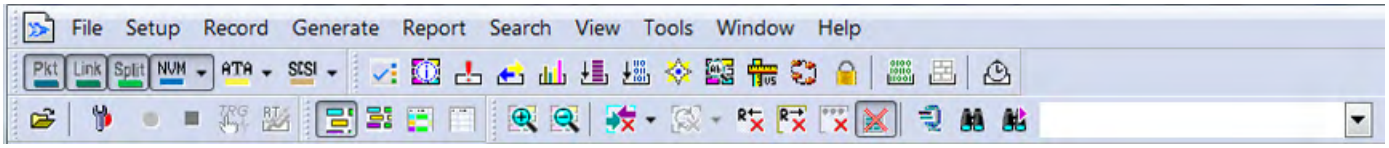


Figure 4.2: Summit T3 Toolbar

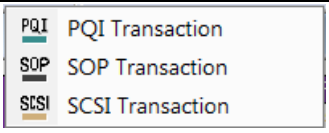
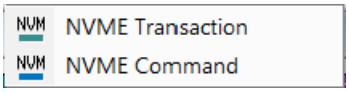
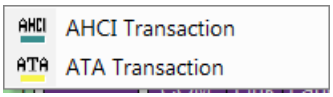
	Opens a previously recorded CATC Trace file.		Stop Recording.
	Setup Recording Options Opens the Recording Options dialog.		Real Time Statistics monitor Opens a window that displays real-time information.
	Start Recording.		

	Displays CATC Trace view.		Displays color spreadsheet view.
	Displays compressed CATC Trace view.		Displays black and white spreadsheet view.

	Zoom in display.		Advanced Hiding Options Opens a dialog box that allows you to select items to hide from view.
	Zoom out display.		Hide Unassociated Traffic Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered "unassociated" when using Split Transaction Level view.

	Hide Training Sequence.		Compact View Toggles compacting of training sequences to analyze CATC Trace data faster, or no compacting to display more data.
	Hide SKIP and Update FC packets.		Find Opens a dialog box that allows you to select one or more items to find in the recording, then searches to that point.
	Hide Upstream recording/ traffic.		Find Next. Repeats last Find or Search action.
	Hide Downstream traffic/ recording.		
		Quick Search window: Allows user to search for pre-defined terms or type in their own term to search for. See “Quick Search Feature” on page 34.	

	View Packet Level data.		View Link Transaction Level data.

	View Split Transaction Level data		View PQI, SOP and SCSI Transaction Level data pull down menus
	View NVME Transaction Level and Command data pull down menus		
			
	View AHCI and ATA Transaction Level data pull down menus		
			

	Trace Expert Generates data on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information.		Opens the Data Flow window. Shows recorded data in a compressed tabular format.
	File Information Lists the conditions under which the recording was made.		Navigator. Shows/hides the Navigator bar - a utility that lets you easily navigate the CATC Trace
	Error Report Opens a window that lists all errors identified in the recording.		Detail View Shows the Detail view of the selected packet.
	Traffic Summary Opens a window that lists all events that occurred during the recording		Running Verification Scripts Runs selected Verifcation Scripts

	Bus Utilization Opens a window that graphically represents various information about the recording.		LTSSM Flow Graph Shows a state diagram of the Link Training and Status State machine.
	Link Tracker Opens a window that displays symbol information per lane.		Opens view for TCG Security Codes. TCG decoding is performed using NVMe Command Level option.

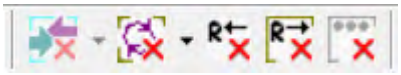
	Displays the Data/Payload window for the current packet.		Displays the Packet Header bar. Opens a window that displays the header information in the current packet, as it would be viewed in the specification.
	Opens the Timing and Bus Usage Calculations window.		

4.4 Multi-Segment Toolbar

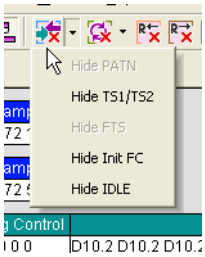
	First Segment. Open first segment in the multisegment CATC Trace.		Index file. This button becomes active if a multisegment CATC Trace file is open and displays the index file for the recording.
	Previous segment. Open previous segment in the multisegment CATC Trace.		Next Segment. Open next segment in multisegment CATC Trace.
			Last segment. Open last segment in multisegment CATC Trace.

4.4.1 Toolbar Hide Buttons

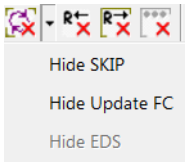
The PCIe Protocol Suite application toolbar has five buttons related to show/hide of CATC Trace file contents. The buttons allow you to quickly adjust the display to your needs.



Hide Training: Brings up a drop-down menu that lets you to hide all or a portion of the packets in the training portion of the CATC Trace.



Hide SKIP, Hide EDS and Update FC: Brings up a drop-down menu that lets you hide SKIP, Update FC and hide EDS packets in a CATC Trace.



Hide Upstream: Hide all traffic from endpoint devices to the root complex.

Hide Downstream: Hide all traffic from the root complex to endpoint devices.

Advanced Hiding Options: Brings up the Level Hiding pane of the Display Options window. Use this pane to tune the show/hide options within the CATC Trace display. You can also select **Setup > Display Options** from the menu to display this dialog.

Hide Unassociated Traffic: Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered "unassociated" when using Split Transaction Level view.

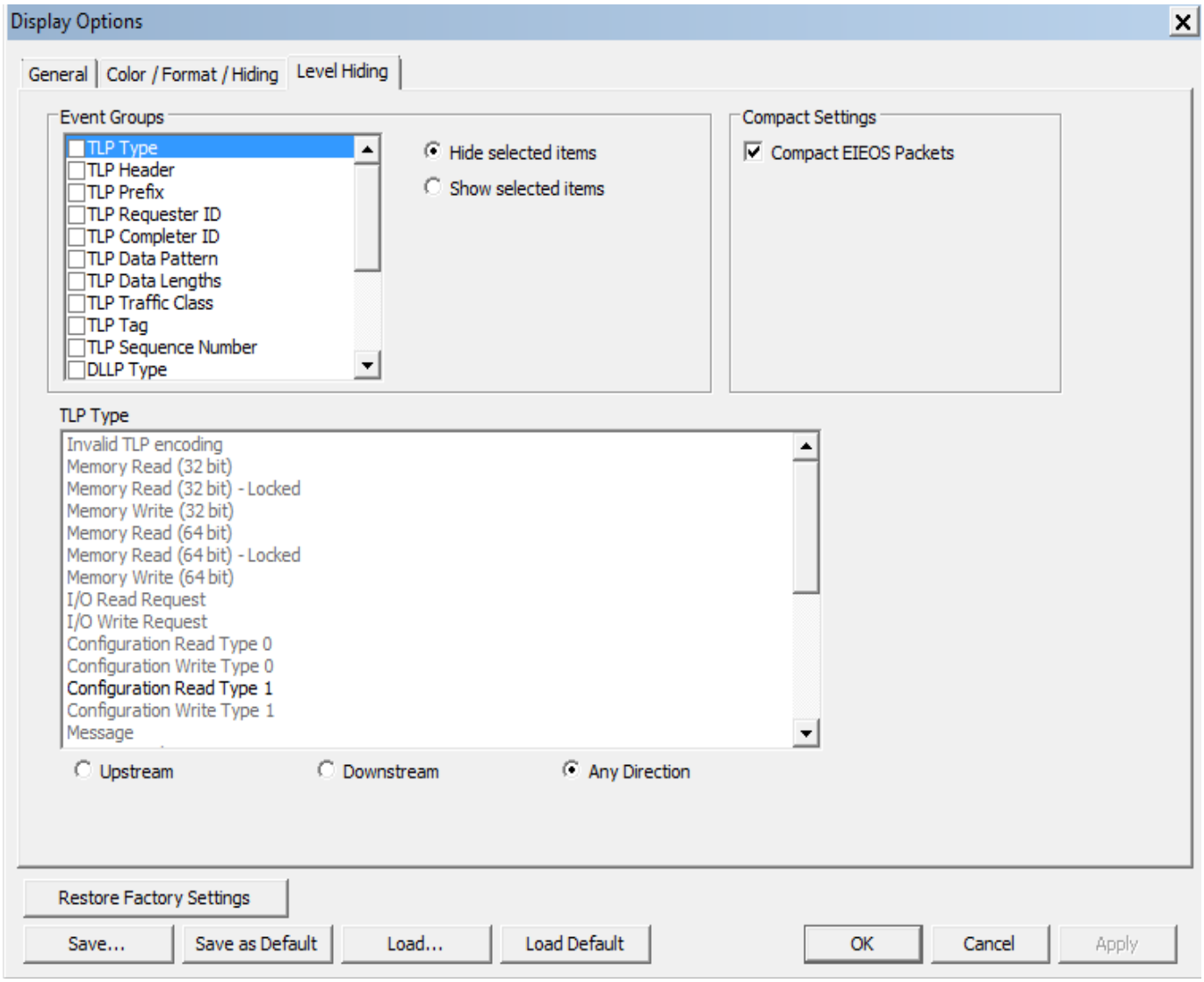


Figure 4.3: Display Options

4.5 Using the Menus

The PCIe Protocol Suite application main display includes the following set of pull-down menus:

4.5.1 File Menu

New PETrainer Script	Creates a new Traffic Generation file.
Open	Opens a file.
Close	Closes the current file.
Save as	Saves all or a specified range of packets to a uniquely named file.
Convert Old Files	Convert CATC Trace files made in previous versions of PE*Tracer* to the new format for PE*Tracer* version 5.0 and higher.
Print	Prints part or all of the current traffic data file.
Print Preview	Produces an on-screen preview before printing.
Print Setup	Setup your current or new printer.
Clean Up Decoder Temp Files	Let's you selectively delete decoder temp files (see "Clean Up Decoder Temp Files" on page 26).
Edit Comment	Create or edit the comment field in a CATC Trace file.
Export >> to Text >> Packets to CSV Text >> to Generator File Format	Saves all or part of a CATC Trace to a text file or traffic generation file. This text file summarizes the traffic in the CATC Trace. Saves the CATC Trace to a text file in Comma Separated Value (CSV) format. Saves the CATC Trace to a generation file.
Exit	Exit the PCIe Protocol Suite application.

File Dialog

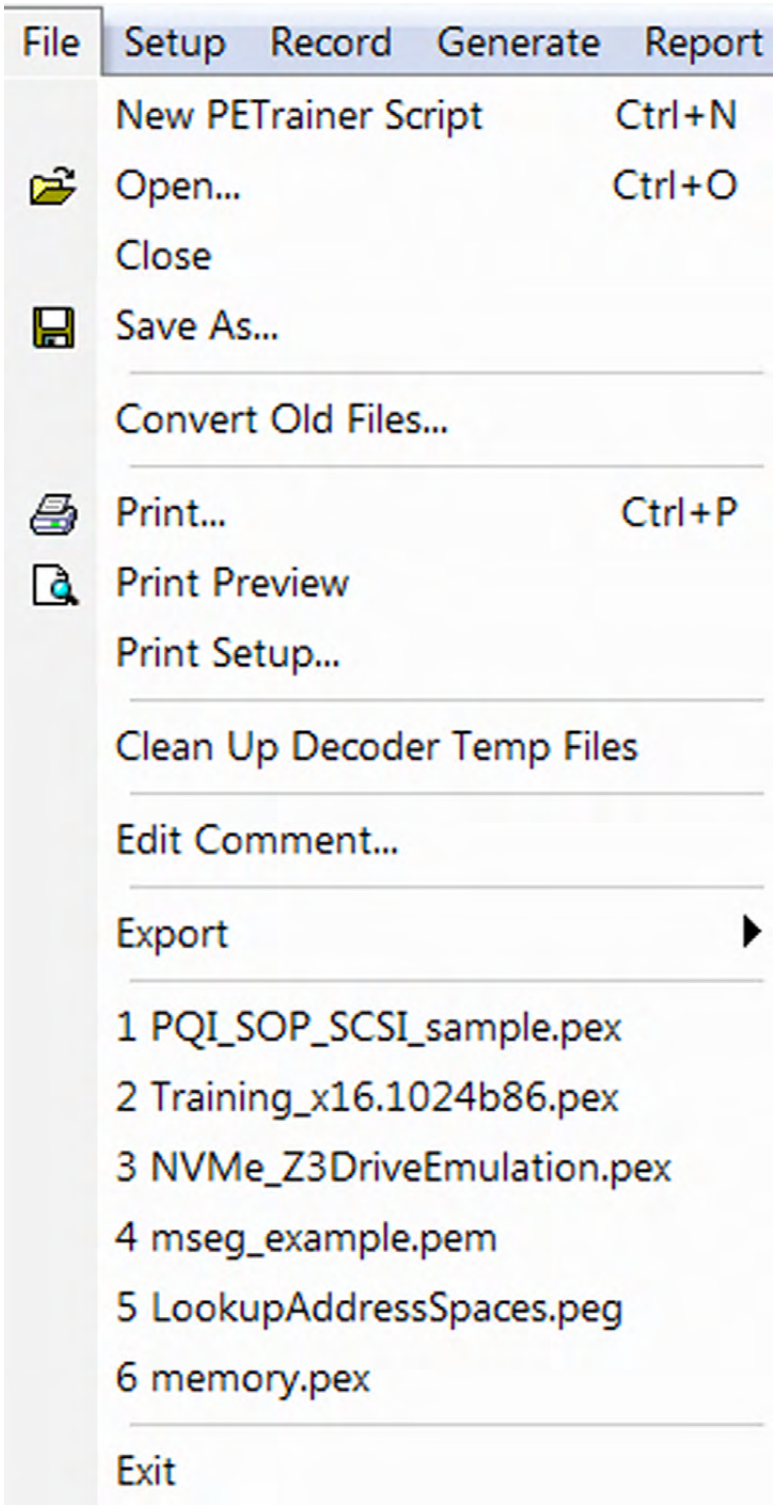


Figure 4.4: File Dialog

Clean Up Decoder Temp Files

This command deletes selected decoder temp files from the selected folder.

The file types effected by this command are:

- *.pem
- *.pex
- *.peraw
- *.mpex
- *.peg

To use this command follow the steps below:

1. The Sample File Folder has Temp files for every trace that has been opened: See Figure 4.5.

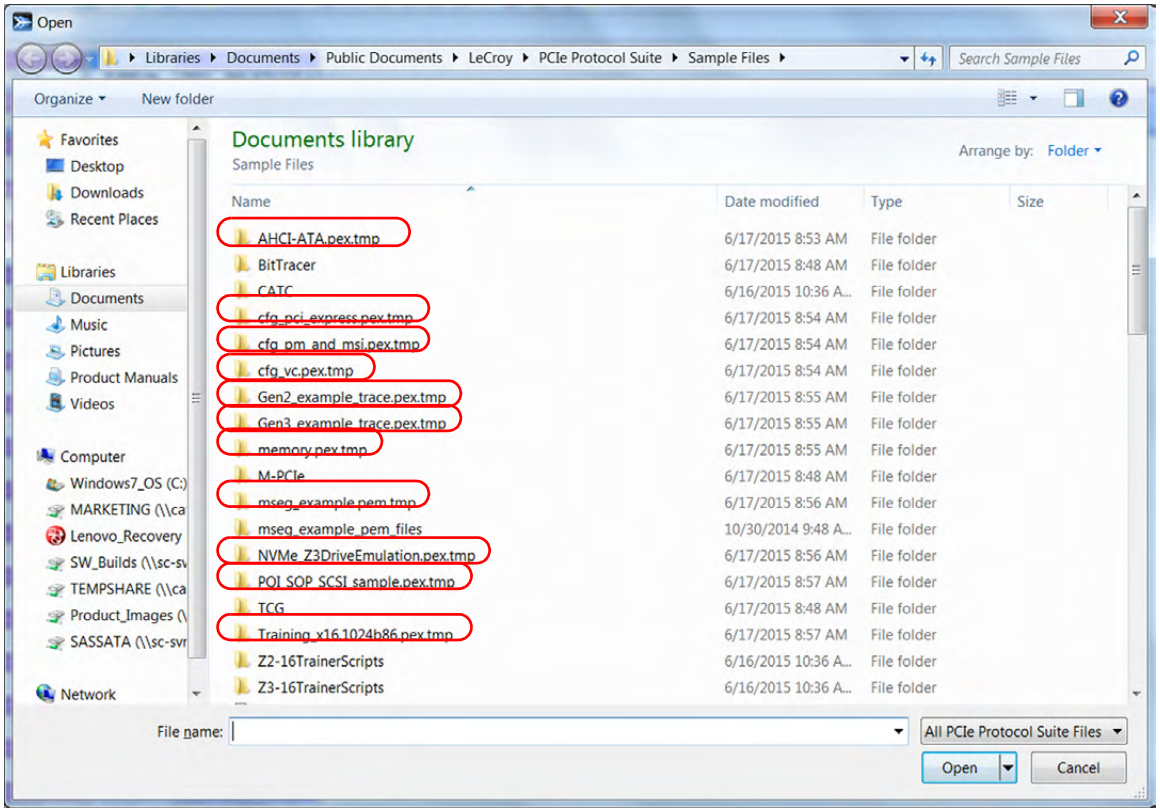


Figure 4.5: Sample Files Folder After Opening a Variety of Traces

2. Now select the File -> Clean Up Decoder Temp Files (see Figure 4.4 on page 25).
3. The following Dialog will pop up : See Figure 4.6 on page 27.

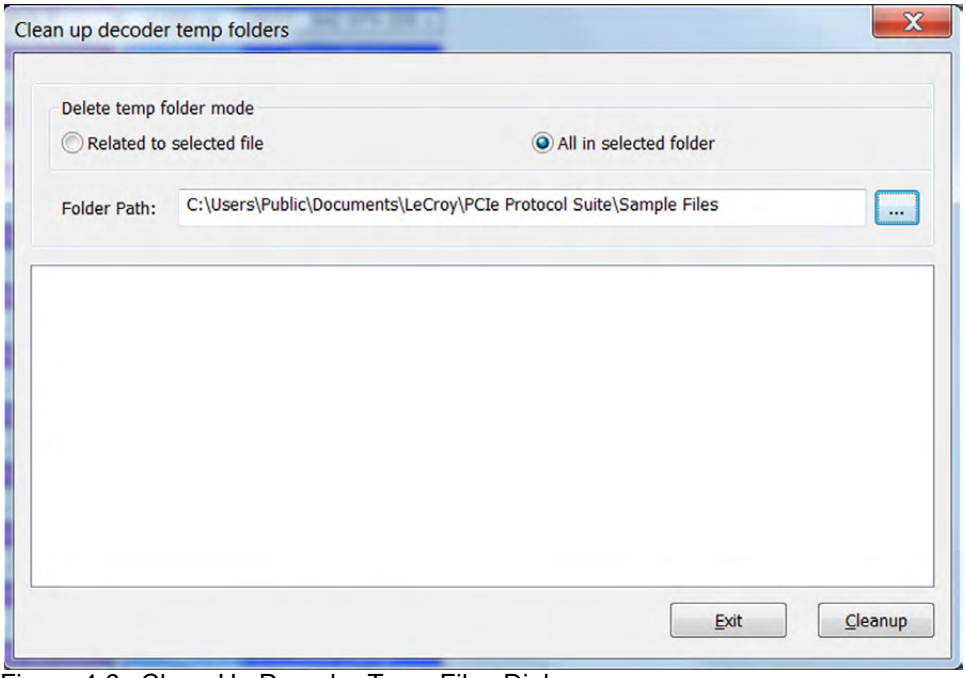


Figure 4.6: Clean Up Decoder Temp Files Dialog

4. Select C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder.
5. Select Cleanup and a Warning Dialog will pop up. See Figure 4.7.

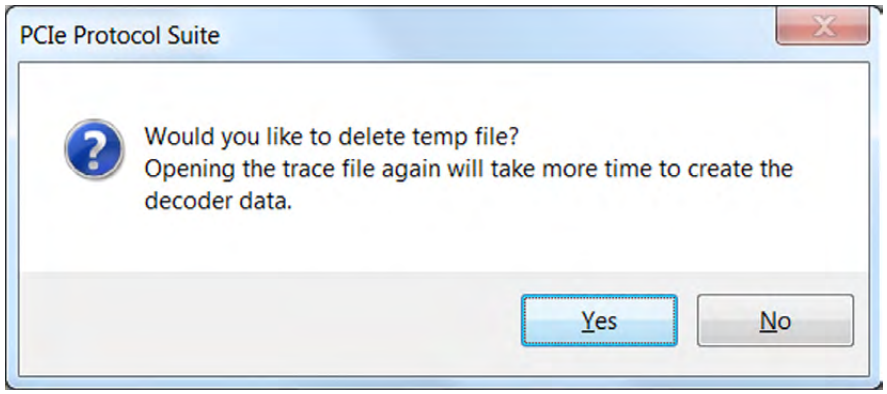

PCIe Protocol Suite
Would you like to delete temp file?
Opening the trace file again will take more time to create the decoder data.
Yes
No

Figure 4.7: Clean Up Decoder Temp Files Warning Dialog

6. Click on Yes, (if files are still in use the Clean Up will Fail, see Figure 4.8 on page 28).

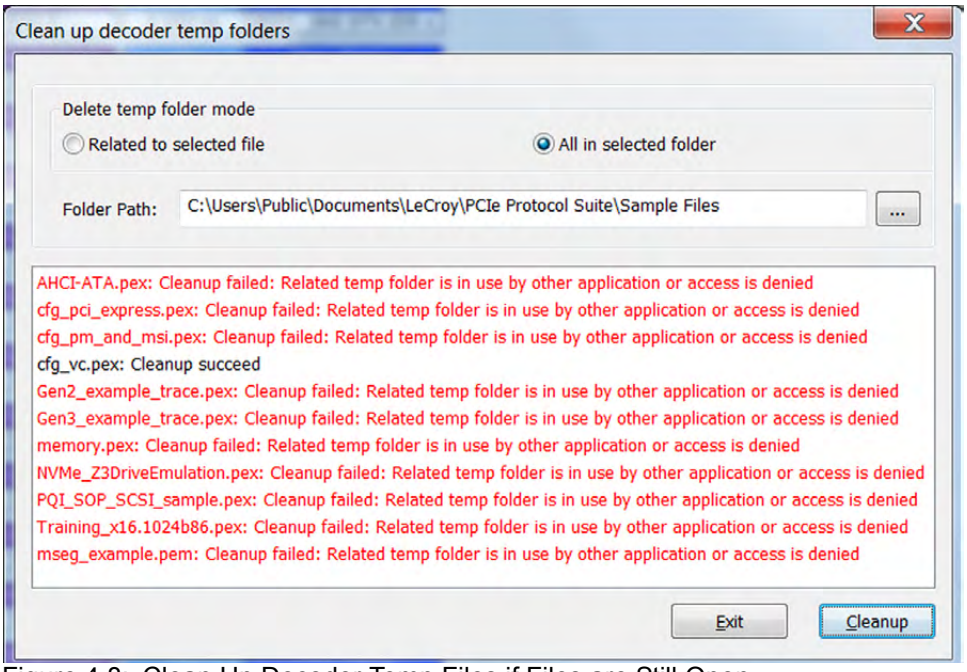

Clean up decoder temp folders
Delete temp folder mode
Related to selected file
All in selected folder
Folder Path:
C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files
...
AHCI-ATA.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
cfg_pci_express.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
cfg_pm_and_msi.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
cfg_vc.pex: Cleanup succeed
Gen2_example_trace.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
Gen3_example_trace.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
memory.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
NVMe_Z3DriveEmulation.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
PQI_SOP_SCSI_sample.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
Training_x16.1024b86.pex: Cleanup failed: Related temp folder is in use by other application or access is denied
mseg_example.pem: Cleanup failed: Related temp folder is in use by other application or access is denied
Exit
Cleanup

Figure 4.8: Clean Up Decoder Temp Files if Files are Still Open

7. Close Files you're not working with.
8. Select Clean Up Decoder Temp Files again.
9. Select Yes on the Warning Dialog.
10. With the files closed, the Clean Up Dialog will respond as shown below (see Figure 4.9).

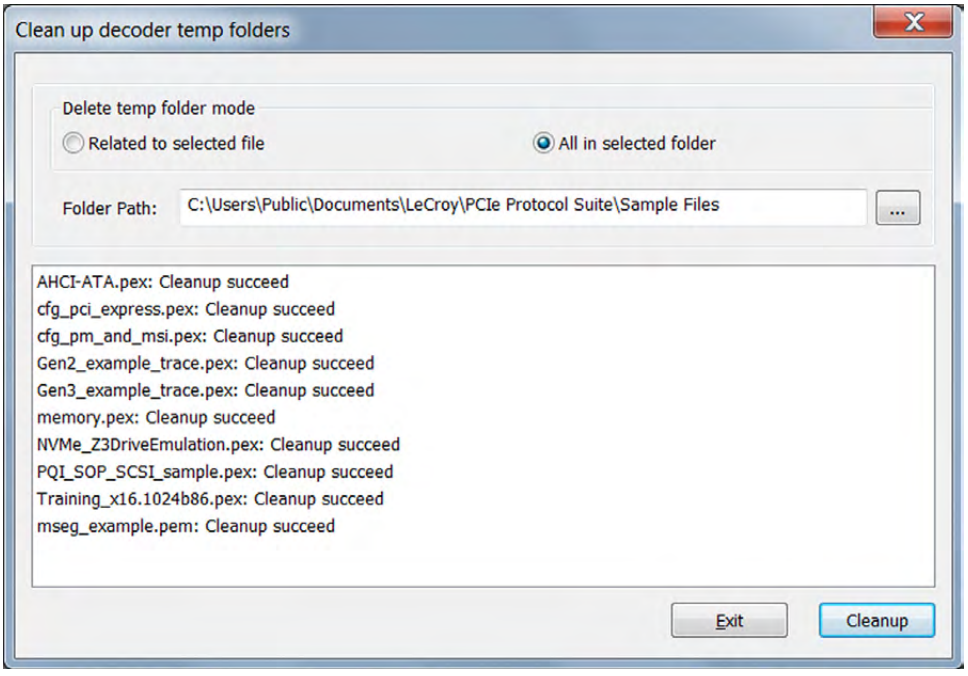


Figure 4.9: Results of Running Clean Up Command

11. Confirm that the Clean Up Command was successful by viewing the C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder contents, (see Figure 4.10).

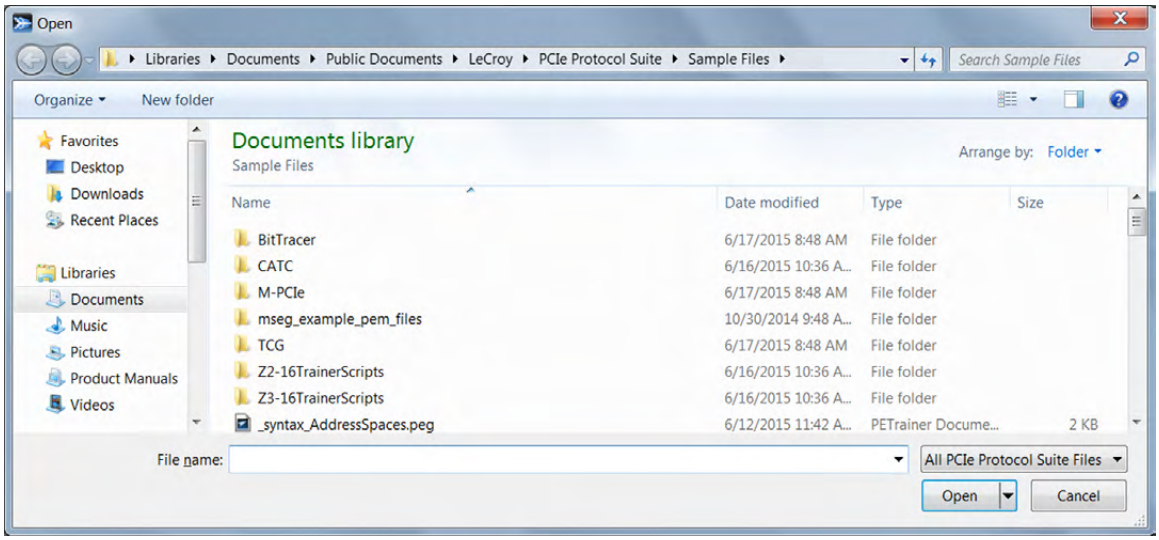


Figure 4.10: Sample File Folder After Temp File Clean Up

12. Compare Figure 4.5 on page 26 with Figure 4.10 to ensure that the .tmp files have been deleted.

4.5.2 Setup Menu

Display Options	Allows you to customize display options such as field colors, field formats and level hiding.
Recording Options	Allows you to customize control and setup features associated with recording, triggering, and filtering recorded events.
Generation Options	The Generation Opt in a traffic generatio convenient alternati
Generation Macros	Opens a dialog for creating buttons on the status bar that can be used to run traffic generation macros.
Update Device	Opens a dialog box that lets you update the BusEngine™ and Firmware.
Calibrate Device	Opens a dialog box that lets you calibrate the BusEngine™ and Firmware.
Launch CrossSync Control Panel	Launches the CrossSync application. The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. See “CrossSync Control Panel” on page 50.
All Connected Devices	Opens a dialog box with a list of locally or remotely connected devices. Allows you to update the BusEngine, Firmware, and your licensing information.

4.5.3 Record Menu

Start	Causes the Analyzer to begin recording traffic.
Stop	Causes the Analyzer to stop recording traffic.
Reupload	Causes the Analyzer to re-send all, or selected portions, of the CATC Trace from the Analyzer buffer to the host machine.
Manual Trigger	Trigger command for Analyzer is generated upon clicking this button.
Reset Link Configuration	Causes the Analyzer to reset the Serdes and thereby reset the Analyzers current link configuration. This command is needed when lane width or other lane settings are changed. Otherwise, the old link configuration is used and errors are generated in the CATC Trace.

4.5.4 Report Menu

Report Menu operations are only available when you are working with a CATC Trace file.

File Information	Displays information about the file contents and describes the conditions of the file's recording (Recording Options, hardware information, and so on).
Error Summary	Displays an error summary of the current CATC Trace file and allows you to go to a specific packet, and save the error file to a uniquely named file.
Traffic Summary	Details the number and types of packets that were transferred during the recording. You can hide, save, send, text, print, and view.
Bus Utilization	Opens a window with graphs of bus usage for the open CATC Trace.
Link Tracker	Opens a window for displaying a detailed chronological view of traffic. The window provides view and navigation options.
Data Flow	Opens the Data Flow Window, providing a tabular view of transactions and their payload.
Trace Navigator	Shows the Navigator bar for navigating a CATC Trace. Shows a snapshot of the recording and allows you to adjust the memory area for the view.
LTSSM Flow Graph	Shows a state diagram of bus activity. Also allows you to navigate through the LTSSM, based on the current recording.
Packet Header	Opens the Packet Header bar, showing the Packet Header information as it would be viewed in the specification.
Packet Data	Opens the Data Window for the current packet or transaction, with the options: Hide, Save, Hexadecimal, ASCII, Decimal, Binary, MSB Format, LSB Format, Big Endian, and Little Endian. Format Line allows you to enter the number of bytes, words, or dwords per line.
Configuration Space	Presents a list of Configuration Spaces. Clicking an item displays the selected Configuration Space in a Configuration Table format.

4.5.5 Search Menu

Search Menu operations are only available when you are working with a CATC Trace file.

Go to Trigger	Repositions the display to show the first packet following the trigger event.
Go to Selected Packet	Repositions the display to a specific packet, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, ATA, SOP and SCSI command transaction levels.
Go to Time	Repositions the display to a specific timestamp.
Go to Marker	Repositions the display to a previously marked packet, Link, Split, NVME, PQI, AHCI, ATA, SOP and SCSI command transaction levels.
Go to SCSI	Allows searching for SCSI commands and sub-commands.: SCSI Operation, Command Status, Task Management, Task Management Response, Error, SCSI Logical Unit Number.
Go to Packet	Allows searching for specific link events: TLP Type, DLLP Type, Ordered Set, Link Event, Traffic Class, DLLP Virtual Channel, TLP Virtual Channel, Direction, Speed, Link Width, Requester ID, Completer ID, Data Lengths, Errors.

Find	Displays the Find dialog to allow searching for various events within a CATC Trace. You can search by Display Level: Packets, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, SATA, SOP and SCSI protocol Transaction. You can search packets by Event Group: TLP Type, TLP Header, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/NAK Seq Number, Ordered Sets, Link Event, Direction, Errors, TS1 Data, TS2 Data. You can search link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag. You can search Link, Split, NVMe and PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address. You can search NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP. You can search PQI transactions by Event Group: PQI Register ID, PQI Admin Functions, PQI Errors. You can search AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, Raw Address, AHCI Direction, AHCI Errors. You can search ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA Port Multiplier, ATA Interruption Reason, ATA Error Type, ATA Input/ Output, ATA Payload Portion, ATA CFS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields. You can search SOP transactions by Event Group: SOP Information Unit ID, SOP Errors. You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers. Find allows you to create complex searches based on numerous criteria.
Find Next	Repeats the previous Find or Search operation.
Search Direction	Allows you to specify a forward or backward search of a CATC Trace file.

4.5.6 Quick Search Feature

The Quick Search feature allows you to either search for a pre-defined term (see Figure 4.11) within a loaded Trace by clicking on the down arrow or by typing your own term into the search window and then moving the cursor into the window and hitting the Enter key.

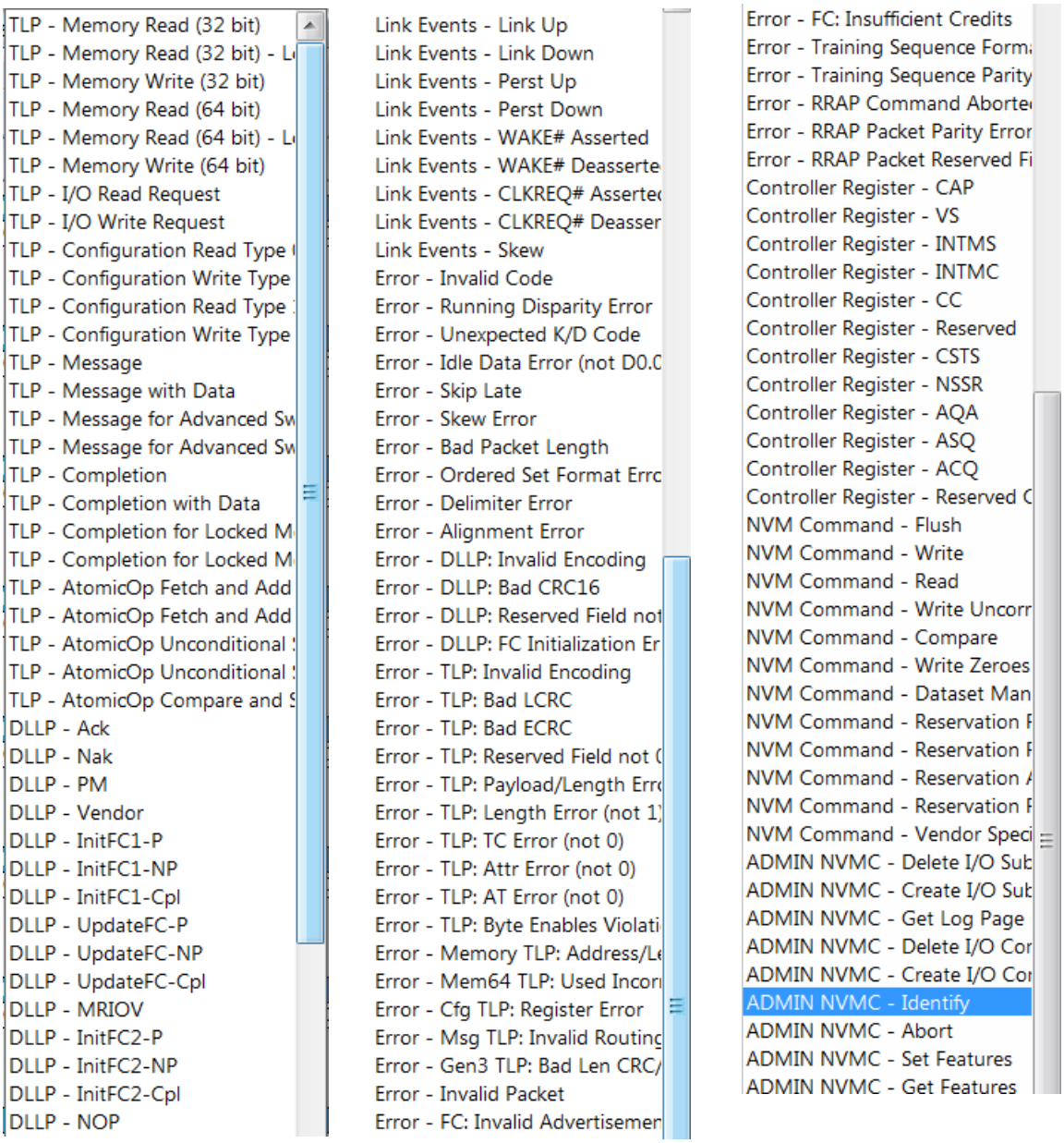

TLP - Memory Read (32 bit)
TLP - Memory Read (32 bit) - L
TLP - Memory Write (32 bit)
TLP - Memory Read (64 bit)
TLP - Memory Read (64 bit) - L
TLP - Memory Write (64 bit)
TLP - I/O Read Request
TLP - I/O Write Request
TLP - Configuration Read Type
TLP - Configuration Write Type
TLP - Configuration Read Type
TLP - Configuration Write Type
TLP - Message
TLP - Message with Data
TLP - Message for Advanced Sw
TLP - Message for Advanced Sw
TLP - Completion
TLP - Completion with Data
TLP - Completion for Locked M
TLP - Completion for Locked M
TLP - AtomicOp Fetch and Add
TLP - AtomicOp Fetch and Add
TLP - AtomicOp Unconditional
TLP - AtomicOp Unconditional
TLP - AtomicOp Compare and S
DLLP - Ack
DLLP - Nak
DLLP - PM
DLLP - Vendor
DLLP - InitFC1-P
DLLP - InitFC1-NP
DLLP - InitFC1-Cpl
DLLP - UpdateFC-P
DLLP - UpdateFC-NP
DLLP - UpdateFC-Cpl
DLLP - MRIOV
DLLP - InitFC2-P
DLLP - InitFC2-NP
DLLP - InitFC2-Cpl
DLLP - NOP
Link Events - Link Up
Link Events - Link Down
Link Events - Perst Up
Link Events - Perst Down
Link Events - WAKE# Asserted
Link Events - WAKE# Deasserte
Link Events - CLKREQ# Asserte
Link Events - CLKREQ# Deasser
Link Events - Skew
Error - Invalid Code
Error - Running Disparity Error
Error - Unexpected K/D Code
Error - Idle Data Error (not D0.0
Error - Skip Late
Error - Skew Error
Error - Bad Packet Length
Error - Ordered Set Format Errc
Error - Delimiter Error
Error - Alignment Error
Error - DLLP: Invalid Encoding
Error - DLLP: Bad CRC16
Error - DLLP: Reserved Field not
Error - DLLP: FC Initialization Er
Error - TLP: Invalid Encoding
Error - TLP: Bad LCRC
Error - TLP: Bad ECRC
Error - TLP: Reserved Field not (
Error - TLP: Payload/Length Erro
Error - TLP: Length Error (not 1)
Error - TLP: TC Error (not 0)
Error - TLP: Attr Error (not 0)
Error - TLP: AT Error (not 0)
Error - TLP: Byte Enables Violati
Error - Memory TLP: Address/Le
Error - Mem64 TLP: Used Incori
Error - Cfg TLP: Register Error
Error - Msg TLP: Invalid Routing
Error - Gen3 TLP: Bad Len CRC/
Error - Invalid Packet
Error - FC: Invalid Advertisemer
Error - FC: Insufficient Credits
Error - Training Sequence Form
Error - Training Sequence Parity
Error - RRAP Command Aborte
Error - RRAP Packet Parity Error
Error - RRAP Packet Reserved Fi
Controller Register - CAP
Controller Register - VS
Controller Register - INTMS
Controller Register - INTMC
Controller Register - CC
Controller Register - Reserved
Controller Register - CSTS
Controller Register - NSSR
Controller Register - AQA
Controller Register - ASQ
Controller Register - ACQ
Controller Register - Reserved C
NVM Command - Flush
NVM Command - Write
NVM Command - Read
NVM Command - Write Uncorr
NVM Command - Compare
NVM Command - Write Zeroes
NVM Command - Dataset Man
NVM Command - Reservation F
NVM Command - Reservation F
NVM Command - Reservation A
NVM Command - Reservation F
NVM Command - Vendor Speci
ADMIN NVMC - Delete I/O Sub
ADMIN NVMC - Create I/O Sub
ADMIN NVMC - Get Log Page
ADMIN NVMC - Delete I/O Cor
ADMIN NVMC - Create I/O Cor
ADMIN NVMC - Identify
ADMIN NVMC - Abort
ADMIN NVMC - Set Features
ADMIN NVMC - Get Features

Figure 4.11: Quick Search: Pre-Defined Terms

This feature will scroll through the entire Trace searching for the requested term and either stop at a highlighted Packet within the Trace or not move to a new positon in the Trace if the term was not found. For more details see “Quick Search Feature” on page 177.

4.5.7 View Menu

Toolbars>>	Displays available toolbars: Standard, View Type, Frequently Used, Analysis, and Transaction Level. Use Customize to display the Windows Customize window.
Script Editor	Displays the Script Editor (only appears if a **.peg** file is open).
Analyzer Network Chat Bar	Opens a chat window for communicating with persons working with networked Analyzers. This command requires that your host machine be attached to a LAN. The Chat window broadcasts messages to whatever hosts have been connected.
Status Bar	Switches display of the Status Bar on or off.
CATC Walk	Lets you play a playlist or manage Playlists (see "CATC Walk Playlist" on page 165).
Unhide Cells	Unhides PQI Reserved, PQI SGL Reserved and SOP reserved cells. You can also select Unhide all.
Zoom In	Zoom in increases the size of the displayed elements.
Zoom Out	Zoom out decreases the size of the displayed elements.
Wrap	Allows the display to wrap.
Synchronize Trace View with Other Views	Synchronize the Trace View with Other Views so that a move in one view repositions the other views.
FC Credits	Toggles a display for tracking Flow Control Credit update and consumption on a PCI Express link.
FC Credits Setup	Allows you to customize the display for tracking Flow Control Credits.
Compact View	Toggles compacting of the Link Training sequence to analyze CATC Trace data faster or no compacting to display more data.
Packet Level	View the current recording at the Packet Level.
Link Transaction Level	View the current recording at the Link Transaction Level.
Split Transaction Level	View the current recording at the Split Transaction Level.
NVMe Transaction Level	View the current recording at the NVMe Transaction Level.

PQI Transaction Level	View the current recording at the PQI Transaction Level.
ACHI Transaction Level	View the current recording at the ACHI Transaction Level.
ATA Transaction Level	View the current recording at the ATA Transaction Level.
SOP Transaction Level	View the current recording at the SOP Transaction Level.
SCSI Transaction Level	View the current recording at the SCSI Transaction Level.
Restore views to default positions	Restores views to the default positions after you click **Yes** on the prompt.

4.5.8 Tools Menu

Configuration Space Editor	Displays the Configuration Space Editor dialog which allows you to either create a new Configuration Space File or open an existing Configuration Space File.
Memory/IO Space Editor	Displays the Memory/IO Space Editor dialog which allows you to either create a new Address Space File or open an existing Address Space File. Select the memory size from the drop-down menu.
TC to VC Mapping	Allows Traffic Classes to be mapped to Virtual Channels for purposes of simplifying navigation (for example, Search > Go to > TLP Virtual Channel) and changing the way the CATC Trace is displayed (for example, in Split Transactions).
Timing Calculations	Starts the mode-less calculator dialog for calculating various timing and bandwidth parameters in the recording file.
PCIe SSD Base Address Mapping	Presents the PCIe SSD Base Address Mapping dialog.
Run Verification Scripts	Presents a list of verification scripts, from which you can run a verification script.

4.5.9 Window Menu

New Window	Opens a copy of the current CATC Trace window.
Cascade	Displays all open CATC Trace windows in an overlapping arrangement.
Tile	Displays all open CATC Trace windows as a series of strips across the display.
Arrange Icons	Arranges minimized CATC Trace windows at the bottom of the display.
Synchronize Traces	Synchronizes the CATC Trace View windows so that a move in one window repositions the other window of the same recording.

4.5.10 Help Menu

User Manuals F1	Click User Manuals or press F1 to access the documentation guide for all Teledyne LeCroy PCIe products.
Display License Information	Opens an information box describing the current license information.
Register Product Online	Register at the Teledyne LeCroy website registration page.
Check for Updates	Check whether a new software version is available. If so, you can download from the Teledyne LeCroy web site. You can select to **Check for updates at application startup**
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail. This requires that an e-mail client be installed and configured on the computer.
Shortcuts List	Displays a list of Keyboard shortcuts.
About PCIe Protocol Suite	Displays version information about the attached Analyzer and its Firmware and BusEngine™.

4.6 Dashboard View

Dashboard View shows state of the link that analyzer is tracking. Click the Dashboard View icon to view the Dashboard View window for the selected device.

Figure 4.12: Dashboard View Icon Displaying Device

Dashboard (see Figure 4.13 on page 38) displays the following information for Upstream and Downstream:

- Link Width
- Link speed
- Per lane activity indication
  - Green - lane is active, analyzer does not detect any signal errors on this lane
  - Orange - lane is active, analyzer detects signal errors on this lane
  - Off - lane is inactive
- Logical to physical lane mapping
- Lane polarity
- Link Number
- NFTS - The number of FTS advertized by the device for each speed

Note: The dashboard display depends on the Recording Options configuration and may not match the current actual link state. For example, if the analyzer is configured to track 2.5 GT/s speed only, the Dashboard View will display 2.5GT/s speed as a current tracking speed regardless of the actual speed of the link.

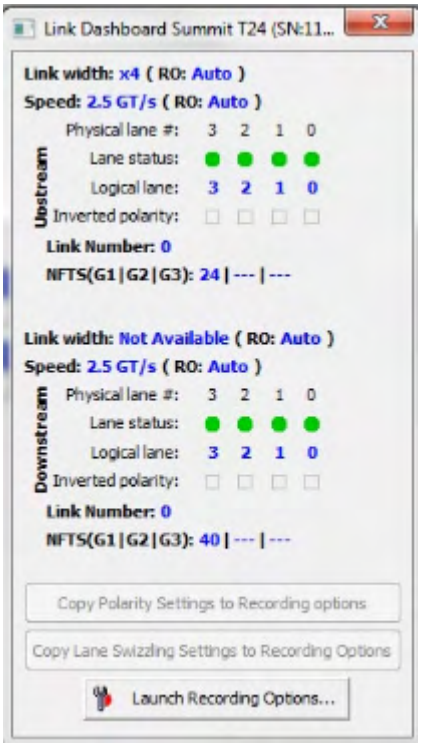

Link Dashboard Summit T24 (SN:11...
Link width: x4 (RO: Auto)
Speed: 2.5 GT/s (RO: Auto)
Upstream
Physical lane #: 3 2 1 0
Lane status:
Logical lane: 3 2 1 0
Inverted polarity:
Link Number: 0
NFTS(G1|G2|G3): 24|---|---
Link width: Not Available (RO: Auto)
Speed: 2.5 GT/s (RO: Auto)
Downstream
Physical lane #: 3 2 1 0
Lane status:
Logical lane: 3 2 1 0
Inverted polarity:
Link Number: 0
NFTS(G1|G2|G3): 40|---|---
Copy Polarity Settings to Recording options
Copy Lane Swizzling Settings to Recording Options
Launch Recording Options...

Figure 4.13: Dashboard View Dialog

You can launch Recording Options for the analyzer from the Dashboard View and adjust recording settings to match the current link configuration. The **Copy Polarity Settings to Recording Options** button allows you to copy the detected polarity into Recording

Options. The **Copy Lane Swizzling Settings to Recording Options** button allows you to copy the detected Lane Swizzling Settings into Recording Options.

Note: Polarity auto detection and lane swizzling detection requires the link to go through link retraining at Gen1 or Gen2 speed. The analyzer has to be configured correctly to track this link retraining.

Launching and Setting Recording Option from Dashboard View

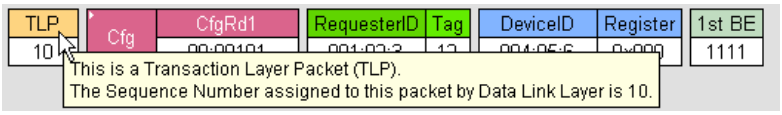
You can select a device and click the **Launch Recording Options as shown in** Figure 4.13 button to go to **Recording Options**. In the Recording Options window the Upstream and Downstream channels can be set manually by unchecking the **Auto-Configure Lane Polarity** checkbox, refer to Figure 5.1 on page 54 (3G). Click on the **Port Polarity Settings to Recording Options** to save the settings.

Note: The lane polarity values are dynamic so this feature allows the user to make the settings and save them for future use.

In the default setting the **Auto-Configure Lane Polarity** checkbox is selected, refer to Figure 5.1 on page 54 (3G).

4.7 Tool Tips

Tool tips provide details about fields within the CATC Trace. To see a tool tip, position your mouse pointer over a field within the CATC Trace.



You can turn off this capability in the Display Options menu.

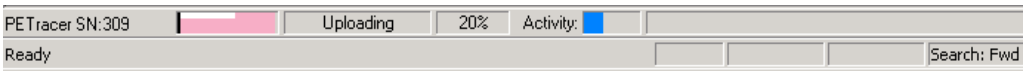
4.8 Keyboard Shortcuts

Keystrokes	Operation
Ctrl + N	New PCIe Protocol Suite script
Ctrl+O	Open file
Ctrl+P	Print
Ctrl+S	Save file
Ctrl + R	Start Analyzer recording
Ctrl + T	Stop Analyzer recording
Ctrl+Home	Jump to first packet
Ctrl+End	Jump to last packet

Ctrl + G	Go to packet ...
Ctrl + F	Search forward
F1	Access documentation
F3	Find next
F6	Next pane
Shift+F6	Previous pane
Ctrl+B	Search backward

4.9 Status Bar

The Status Bar is a gray bar that runs along the bottom of the application window.



From left to right:

PCIe Protocol Suite SN:309: Analyzer Serial Number

Ready: Analyzer Status

Recording Progress Bar: The colored bar to the right of the serial number represents how much traffic has been recorded. The trigger point is indicated by the black line at the left side of the bar. In this example, the trigger occurred at the very beginning of the CATC Trace. If the trigger is set in the middle of the CATC Trace, the line is positioned in the middle of the bar. Additionally, the color of the bar is different on each side of the trigger point. For examples, see “Recording Progress Bar” on page 40. The white strip along the top edge of the color bar indicates how much traffic has been uploaded from the Analyzer buffer to the host machine.

Uploading and 20%: Indicates the Analyzer's recording status, what part of the recording process the Analyzer is now in. In this example, the Analyzer is in the upload stage and has completed 20% of the upload from the Analyzer to the host machine. See “Recording Status” on page 41 for details on other status messages.

Activity: The colored bar moves to indicate that the Analyzer is currently recording.

Search: Fwd: Indicates search direction. The direction can be toggled to **Search: Bwd** by double-clicking the search direction or by selecting **Search Direction** from the Search menu.

4.9.1 Recording Progress Bar

This indicator bar changes color to reflect the recording progress.

- Black vertical line is at the location of Trigger position.
- Black vertical line wiggles when Trigger Position is nearly reached.
- Field to right of Trigger Position changes color to indicate post-trigger activity.

- Upper half of progress indicator turns white when recording is complete.

4.9.2 Recording Status

The second segment from the left in the Status Bar indicates recording status.

During recording, the current Recording Status is in a segment. When you activate the **Record** function, this segment flashes a message depending on the selected Recording Options, such as **Waiting for Trigger**, **Uploading** or **Triggered**.

- The status bar displays **Waiting for Trigger** while waiting for trigger to occur based on the settings defined in the Recording Options.

Figure 4.14: Status Bar - Waiting For Trigger

The status bar displays **Uploading** when recording is complete and is being uploaded.

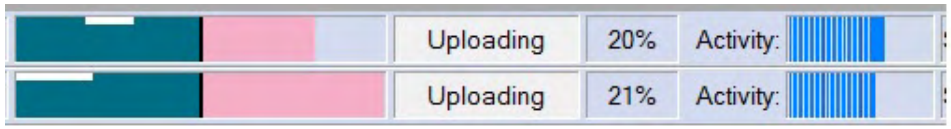


Figure 4.15: Status Bar - Uploading

The status bar displays **Triggered** when the trigger condition has occurred, but uploading has not commenced yet.

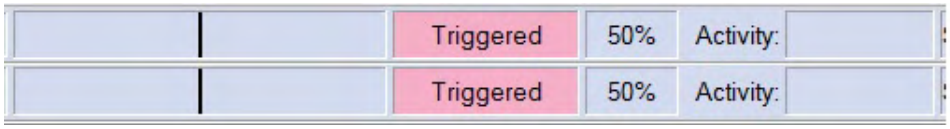


Figure 4.16: Status Bar - Triggered

As uploading progresses, the percent increases to 100. You can abort this upload if you wish by pressing the **ESC** button on your keyboard or

clicking in the Tool Bar.

4.9.3 Recording Activity

The third segment displays recorded activity as a series of blue vertical bars. The more vertical bars that display, the greater the amount of activity recording. If there are no vertical bars, there is no recording activity.

During uploading, the percent of the completed upload displays.

4.9.4 Search Direction Indicator

The fourth segment in the status bar indicates search direction. The direction can be changed by selecting Search Direction from the Search menu.

4.10 Making a PCI Express Recording

After connecting the Analyzer to the device(s), you must configure the Recording Options. Then you can test the Analyzer by creating a 16-MB snapshot recording.

To make this recording, follow these steps:

1. From the **Setup** menu, select **Recording Options** and click the **Switch to Simple Mode** button.
2. Select the **Simple Mode** tab (see Figure 4.17).

   The following window displays the factory default settings in **Simple Mode**, such as Snapshot and 16-MB buffer size. For your first recording, select the proper speed and link width.

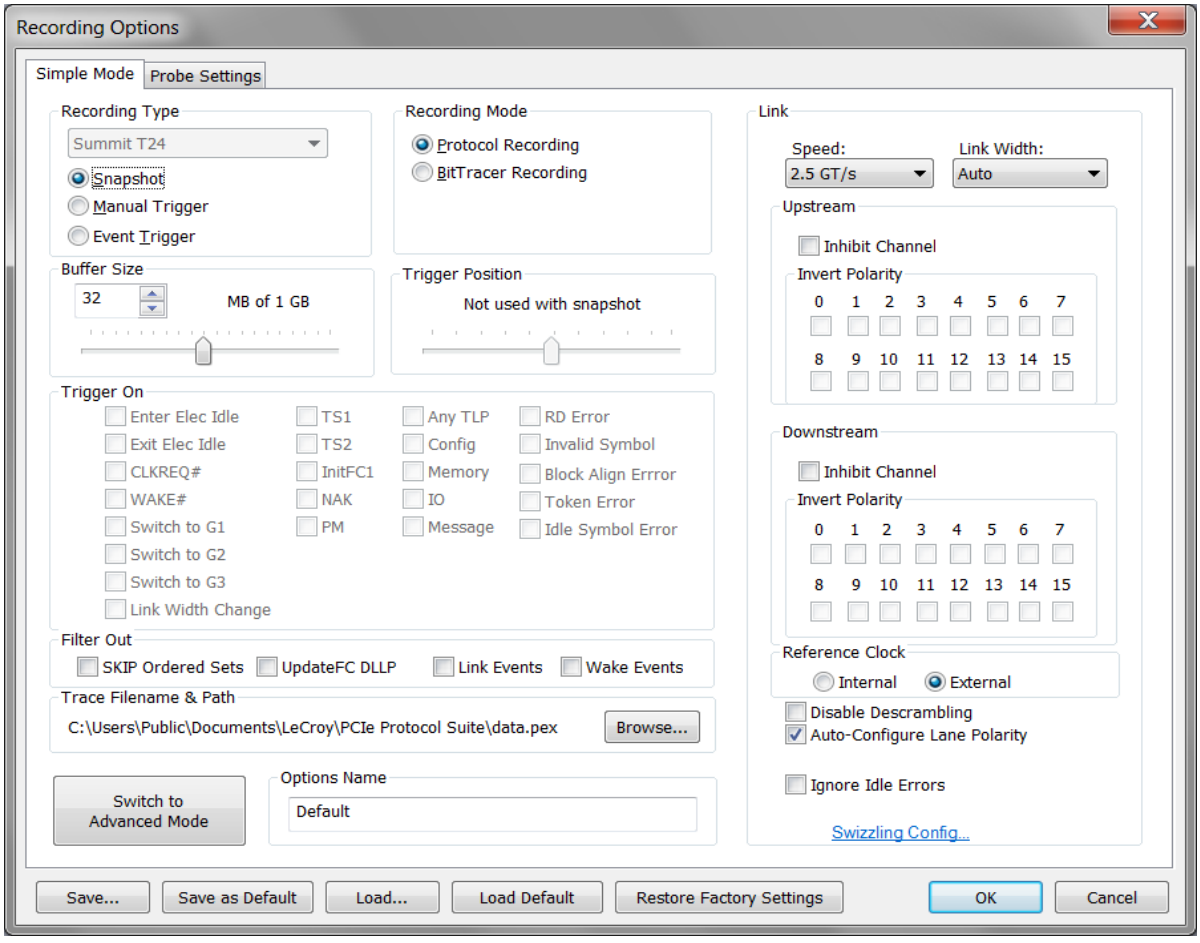


Figure 4.17: Summit T24 in Simple Recording Mode

3. In the **Link** section, specify the lane width of the PCI Express link to be analyzed. The rest of the settings in this section can be left at the factory defaults for most PCI Express systems.
4. For multi-lane PCI Express links, the Analyzer needs to observe link training in order to record link traffic correctly. If link training (or re-training) is not easily controllable for the devices under test, the Analyzer includes the capability to force link training by disconnecting and reconnecting the PCI Express link.

Note: For x1 PCI Express links, it is not necessary for the Analyzer to observe link training in order to record link traffic; this step may be skipped.

5. Click **OK** at the bottom of the Recording Options dialog to apply the Analyzer recording settings specified.
6. Click the **Record** button.

4.10.1 Stopping a Recording

You can stop the recording process at any time by pressing the **Stop** button . This causes the Analyzer to stop the recording and upload the CATC Trace to the host machine. If you press the **Stop** button again, the Analyzer temporarily halts the upload process and opens the following dialog box.

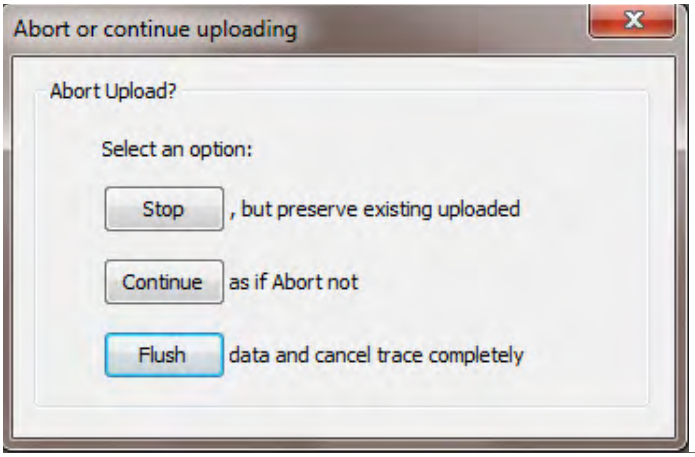


Figure 4.18: Abort Upload

This dialog presents options for stopping, continuing, or aborting the upload:

- **Stop**: Aborts further CATC Trace upload and displays whatever data that has already been uploaded.
- **Continue**: Resumes the upload. This command tells the Analyzer to finish uploading whatever CATC Trace data is still in its buffer.
- **Flush**: Flushes the CATC Trace without saving or displaying it.

If you allow the traffic data to be uploaded, it is automatically saved on the host machine's hard drive as a file named **data.pex** or the name you assign as the default filename in the recording options.

4.10.2 Saving a Recording

1. To save a current recording for future reference, select **Save As** from the File menu.
2. Give the recording a unique name, then save it to the appropriate directory.

4.11 PCIe Protocol Suite Files

The PCIe Protocol Suite software creates and uses different kinds of files:

- **CATC Trace Files**: Recorded traffic
- **Recording Options Files**: Configuration file that contains the various options selected in the Recording Options dialog to configure the recording
- **Display Options Files**: Configuration file that contains the options selected in the Display Options dialog to configure how traffic is displayed

4.11.1 CATC Trace Files

PCIe Protocol Suite records PCI Express traffic into a CATC Trace file with the default name **data.pex** or any other that you specified in the Recording Options. This file is overwritten with new data each time PCI Express traffic is recorded.

If you want to save a CATC Trace, use the **File > Save As** function. This option allows you to save the current CATC Trace to a unique file name, thereby ensuring that it is not overwritten. This option also allows you to save a range of packets in a CATC Trace file.

You can pre-define the name of the recorded CATC Trace file using the Trace Filename and Path option in Recording Options.

4.11.2 Recording Options Files

Recording Options files are created when you set recording options. These files use the **.rec** extension and contain recording option information.

4.11.3 Display Options Files

Display Options files are created when you set display options. These files use the **.opt** extension and contain the display options information.

4.12 Saving CATC Trace Files

This section describes how to save a CATC trace file.

4.12.1 Using the Save As Function

When you record a CATC Trace file, the Analyzer software provides a pre-defined name to the CATC Trace file (**data.pex** or any other that you specified in the Recording Options). If you do consecutive recordings, each time the previous recording is overwritten. If you see a recording you want to analyze later, you need to give a unique name to the CATC Trace file, so it is not overwritten with the next recording.

Also, when you analyze a recorded CATC Trace file, you might be interested in preserving just a part of the PCI Express traffic that was recorded. If you save a portion of a CATC Trace file, it can get significantly smaller, allowing you to attach it to an e-mail.

To save a portion of a CATC Trace file or the whole file to a unique name, select **Save As** from the File menu (see Figure 4.19 on page 45).

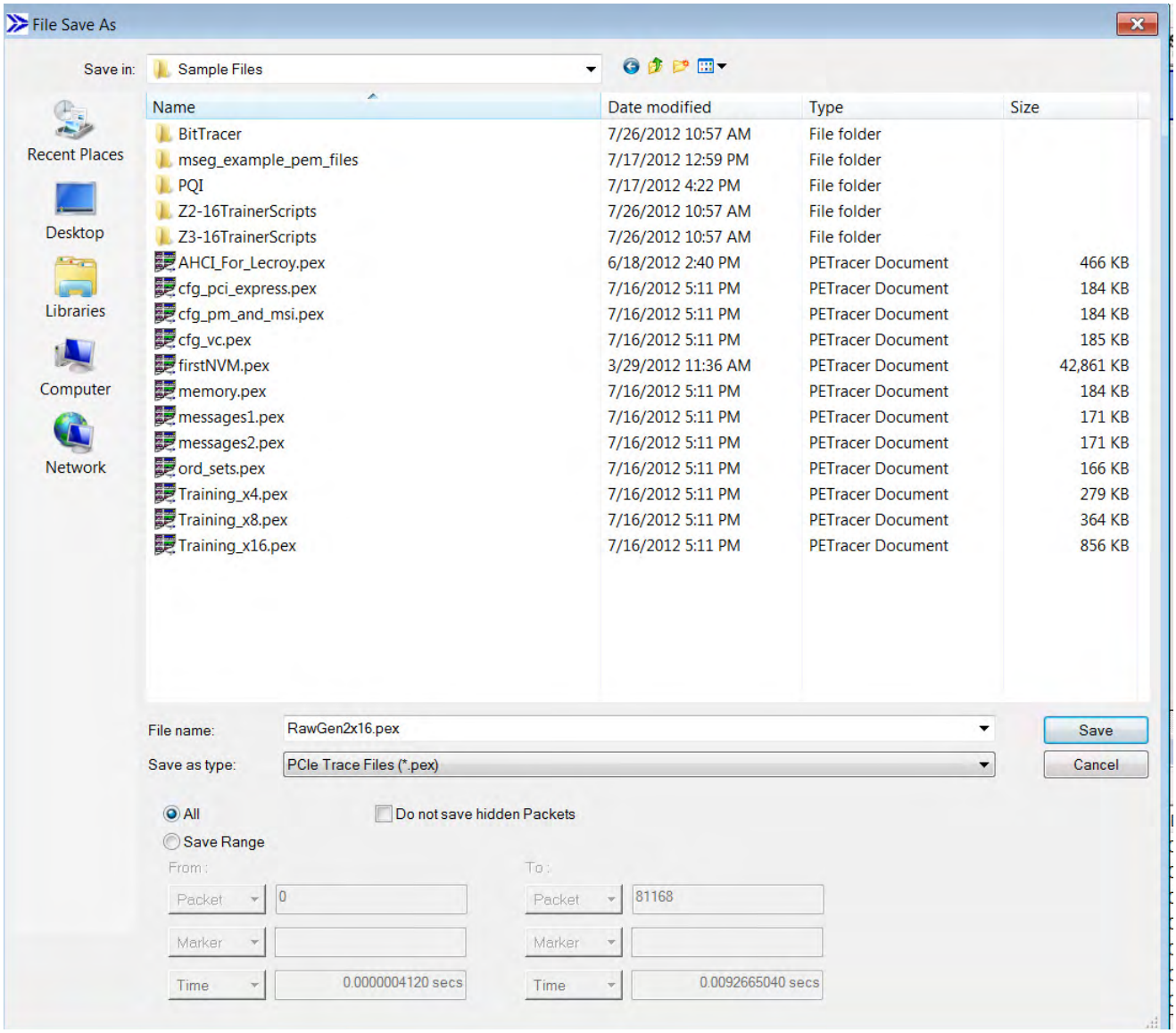


Figure 4.19: File Save As Dialog

If you want to give a unique name to the CATC Trace file, select the **All** option and keep **Rename original file** checked. This is the default setting for the dialog.

4.12.2 Saving a Portion of a CATC Trace

If you want to save a portion of a CATC Trace file, select **Save packet range**. Enter starting and ending packet numbers in the **From Packet** and **To Packet** fields. By default, it has the numbers of the first and the last packets in the file. The software is going to save all the packets in specified range to the new file, unless you have **Do not save hidden packets** checked. In this case it is going to save all packets in the range, EXCLUDING the currently hidden packets.

4.12.3 Trace File Structure

The captured trace file has an extension of ".pex". When the trace file is loaded, additional decoding and data reduction is done which results in additional files of data which are placed in a folder of the same name as the trace file (with the extension ".tmp"). This allows the trace file to be loaded and displayed quickly during subsequent viewings.

When copying a trace file, or sending it to someone, you can chose to send just the .pex file. In that case, the software re-generates the additional folder and files when the trace is first opened. The other choice is to send the additional folder with contents along with the .pex file, which will save the rebuilding effort when the file is opened again. The choice is up to the user. If you do NOT want these files kept, and don't mind the extra time it takes to re-build these every time you load a trace file, then you can select this in the Recording Options.

If the additional files ever become out of date (newer software structures from a new release, etc.) or if any of the files are lost or damaged, the software will rebuild a fresh version of the information.

4.13 Exporting a CATC Trace File

By default, PCIe Protocol Suite saves CATC Trace files in the **.pex** format. However, you can export a CATC Trace to a file in any of the following other formats:

- Text
- Comma Separated Value (CSV)
- Generator file format

Exporting to Generator file format is a simple way to create a script file from your CATC Trace. Only PCI Express packets will be exported to a script. All transaction levels, including supported SSD decodes, can be exported to Text or CSV Text.

To export a CATC Trace file, select **File > Export**.

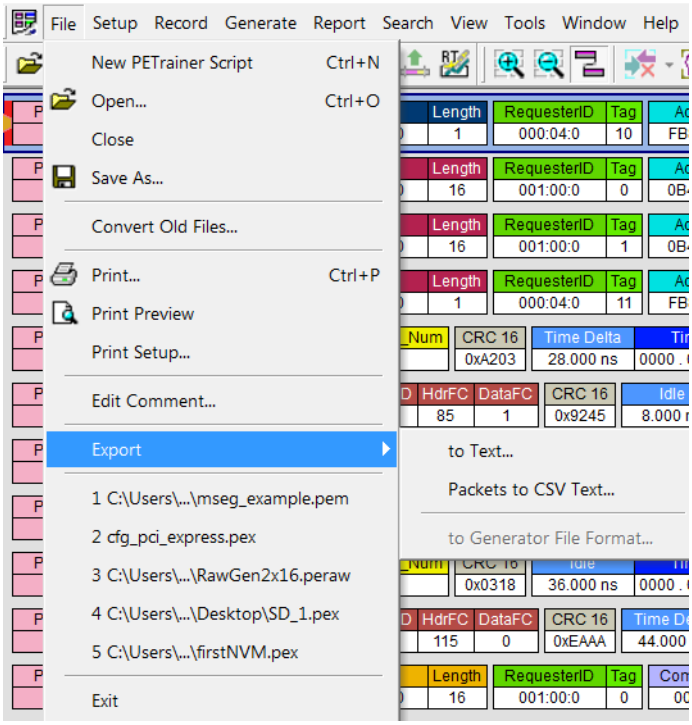


Figure 4.20: Exporting a File

4.14 Printing Data Files

To print all or part of the open CATC Trace:

1. Select **File > Print** from the menu or

   click the **Printer** button on the toolbar.

   The Print Packets dialog opens (see Figure 4.21 on page 48).

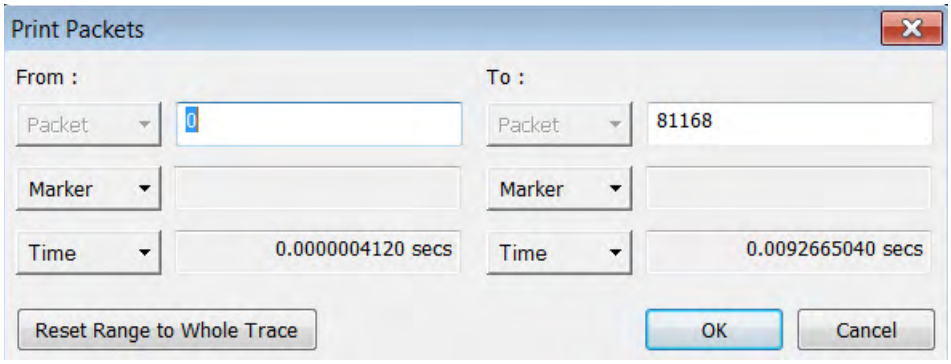


Figure 4.21: Print Packets Dialog

2. To select a range of packets, enter values in the **From packet #** and **To packet #** fields and click **Print**.
3. To print an entire file, leave the From and To fields empty and click **Print**.

The specified traffic information is printed as currently displayed, in color or gray scale as supported by your printer. Any CATC Trace File comments you entered are printed following the current document name at the top of each page.

Note: CATC Trace File comments can be created by using **Edit Comment** on the File menu.

4.15 Analyzer Chat Window

PCIe Protocol Suite has a Chat window that allows you to communicate with users on remote host machines. For Chat to work, two conditions must be met:

- The host machines must have PCIe Protocol Suite software installed and running.
- The host machines must be listed in each other's All Connected Devices list. This means that your host machine must have the remote host machine listed in its Analyzer Devices window and the remote host machine must have your host machine listed in its Network Browse window.

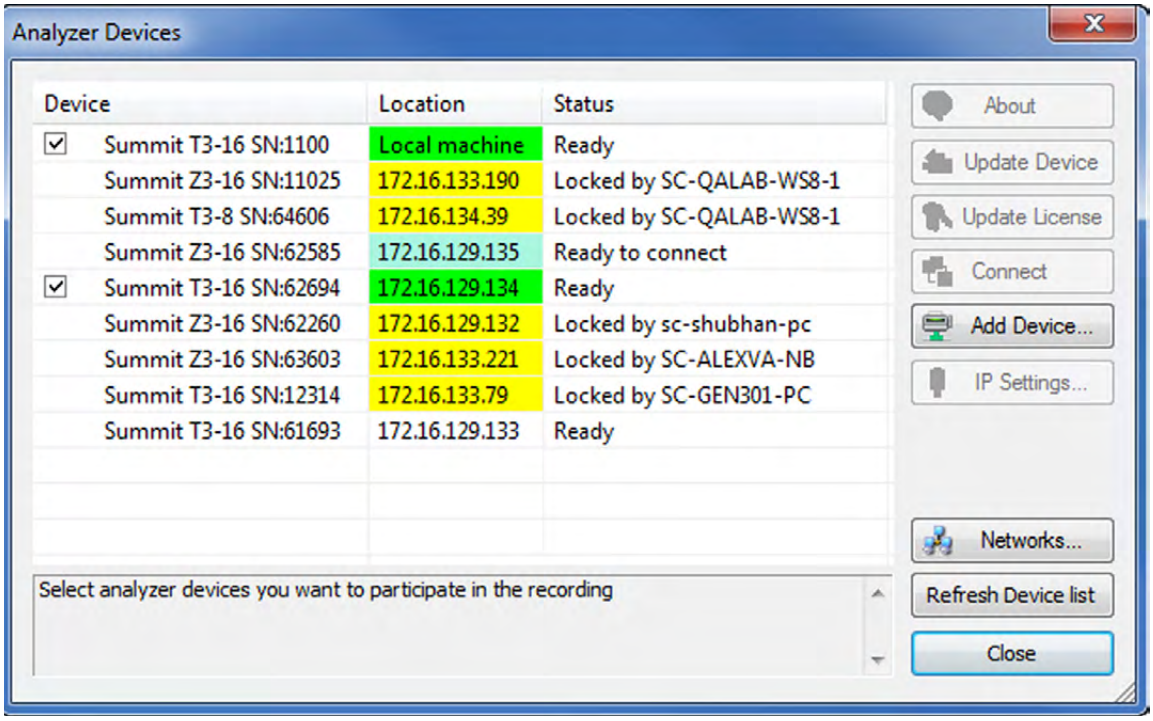


Figure 4.22: Typical Analyzer Network Dialog

If the above conditions are met, a Chat session is initiated by running the command: **View > Analyzer Network Chat Bar**. The following dialog box opens.

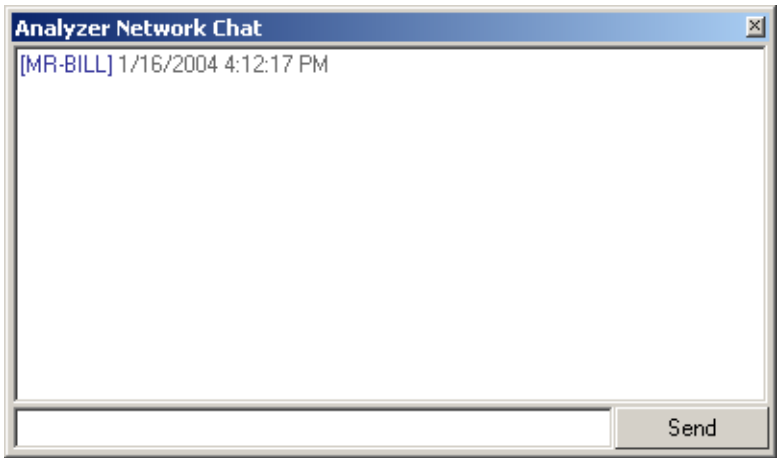


Figure 4.23: Analyzer Network Chat Dialog

Enter some text, then press **Send**. The message is then broadcast to all host machines listed in your network browse window. If a target host machine also lists your host machine in its Network Browse window, then it can receive your message. When the message arrives, the Chat window automatically opens.

4.15.1 CrossSync Control Panel

The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. It supports a wide combination of Teledyne LeCroy's flagship analyzers including PCI Express, USB, DDR, Serial ATA (SATA), Serial Attached SCSI (SAS), Fibre Channel (FC) and Ethernet.

CrossSync is Teledyne LeCroy's analyzer synchronization solution that enables time-aligned display of protocol traffic from multiple daisy-chained analyzers showing packet traffic from multiple high-speed serial busses. A lightweight software control panel allows users to select analyzers for synchronization and manage the recording process. Captured traffic is displayed using the latest analyzer software (in separate windows) with all the protocol specific search and reporting features.

Captured packets are displayed in separate windows that share a common time scale. Navigating the traffic in either direction will scroll to the same timestamp in a synchronized window. When using the CrossSync option, users can access the full complement of analysis capabilities available within the individual Teledyne LeCroy software. Search, reporting, and decoding all operate normally.

This feature is available with the Teledyne LeCroy PCIe Protocol Suite software application.

Launching the CrossSync Control Panel

To launch CrossSync from the PCIe Protocol Suite software application, select the '**Launch CrossSync Control Panel**' entry in the 'Setup' menu (see the screen below). Or, you can launch CrossSync from the '**Start**' menu.

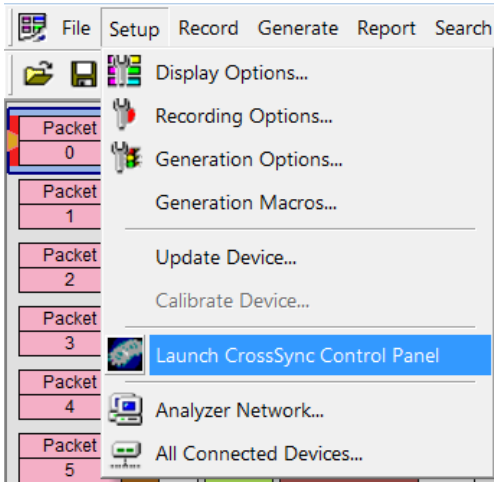


Figure 4.24: Launching CrossSync from the PCIe Protocol Suite Application

Please refer to the *CrossSync Control Panel User Manual* for more information.

Chapter 5

Recording Options

5.1 Recording Overview

After installing the software recording options should be set prior to recording. The recording options define the behavior of the Summit T24 during recording. You can create, save and load previously saved recordings. This section explains how to define recording options on the Summit T24 Analyzer.

5.2 General Tab

The Recording Options dialog is used to configure a recording.

To open the Recording Options window, click or select the command **Setup > Recording Options**.

Note: There are separate sets of Recording Options for each Analyzer type. To set the Analyzer type, select the appropriate platform from the Target Analyzer menu in the General tab of the Recording Options.

The General tab displays options that affect all recordings (see Figure 5.1 on page 54).

5.3 Recording Options-General Tab

This section describes the General Tab recording options

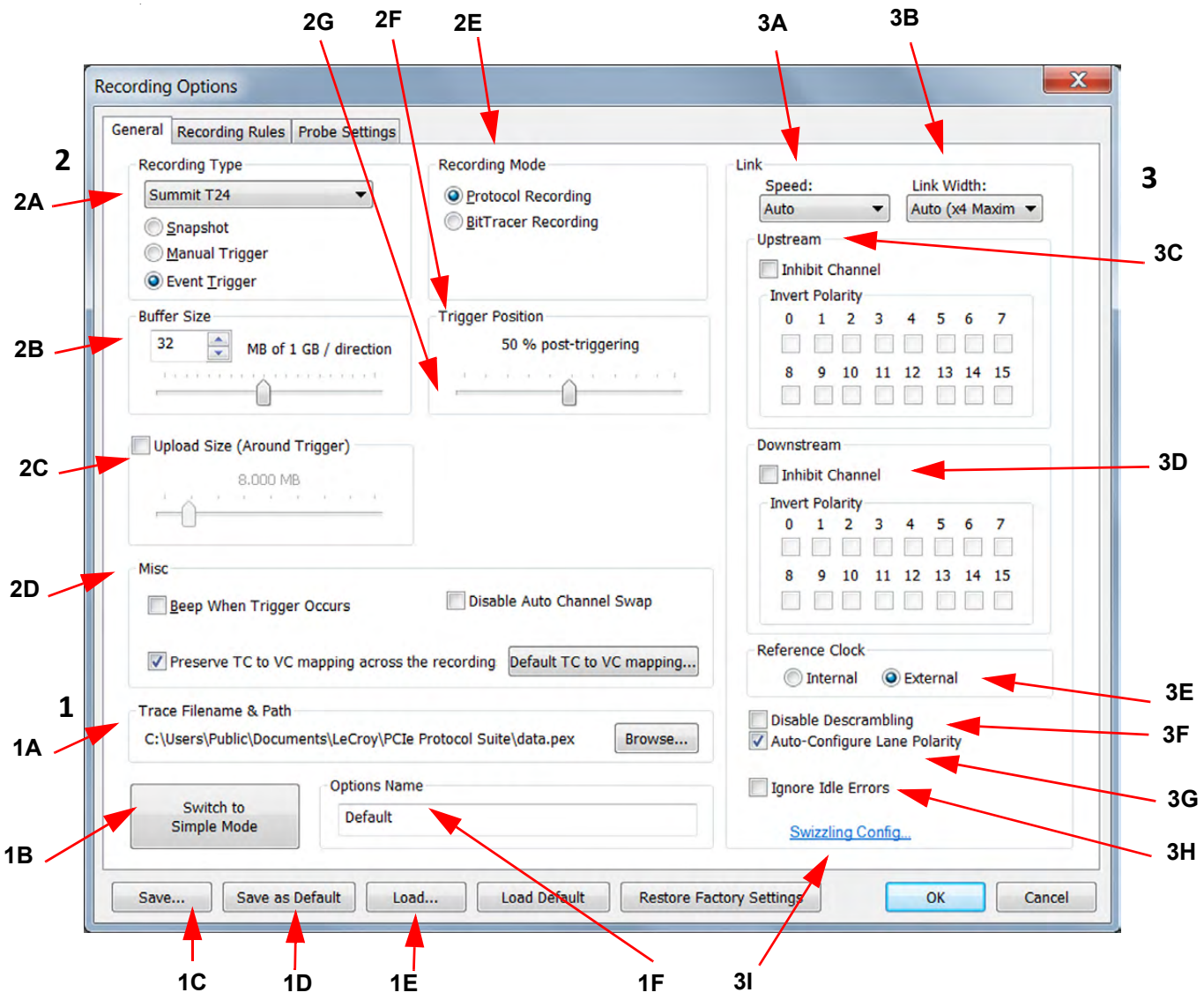


Figure 5.1: Summit T24 in Recording Options

Note: Please refer to the figure callout numbers in each of the sections below to co-relate to Figure 5.1 shown above. For instance, for Simple and Advanced Mode, see Figure 5.1: 1B.

5.4 Simple and Advanced Mode

The recording options can be defined in Simple or Advanced modes. The Simple Recording and Advanced Recording options are the same in functionality, only the interface displayed is different. The Simple Mode allows quick access to commonly used options. The recording options are the same in both modes (See Figure 5.1: 1B).

Clicking on the **Switch to Simple Mode** toggles you between Simple and Advanced Mode (see Figure 5.2 on page 55).

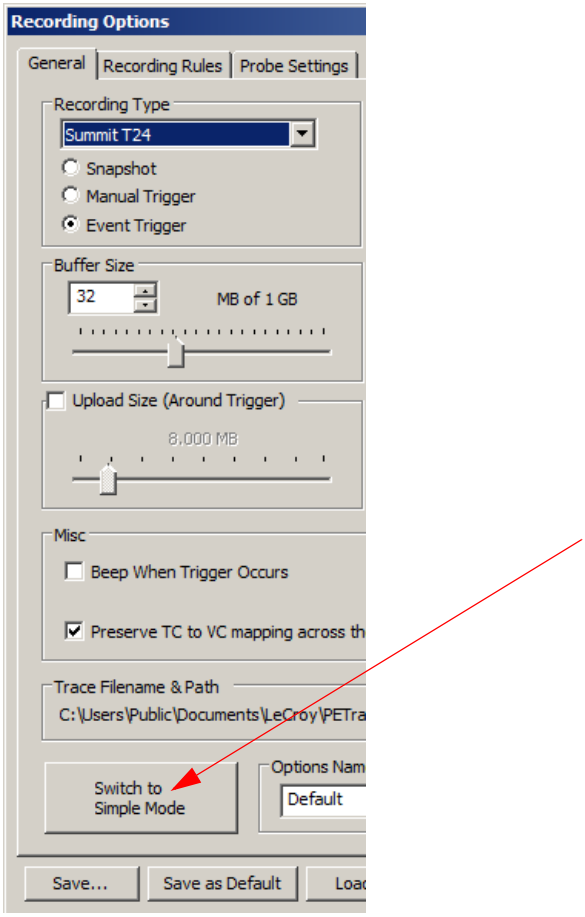


Figure 5.2: Switch to Simple Mode Button.

5.5 Trace Filename and Path

The Trace Filename and Path button sets the path and CATC Trace name for the recording. It allows you to change the default file name and path for the recorded CATC Trace file. The pre-defined name is **data.pex**. See Figure 5.1: 1A

1. Select the **Recording File Name** button.
2. The Specify Trace File Name dialog opens to navigate to the directory you want.
3. Enter the new file name in the File name field.
4. Click the **Save** button.

   This action does not do any immediate save operation. It just changes the default name and uses it in subsequent recordings.

5.6 Saving and Loading Previously Saved Recording Options

You can save a recording or load previously saved recordings. In the general tab the following Save options are available (see Figure 5.1 on page 54).

5.6.1 Setting Default Recording Options

To save the current recording options into the default Recording Options file:

Click **Save As Default**. The default file for the options is **default.rec**.

When the PCIe Protocol Suite software begins execution, it automatically loads the **default.rec** file, if one exists.

Options Name: See Figure 5.1 on page 54: 1F

The Options Name is a descriptive, supplemental label that you can assign to a Recording Options file so you can easily recall what settings are in the Recording Options file.

For example, if your Recording Options file were named **StandardSettings.rec**, your Options Name could be a long descriptive label such as **Standard Record Options used for all normal Recordings**.

Save: See Figure 5.1 on page 54: 1C

Saves the current options to whatever file name you provide.

Save As Default: See Figure 5.1 on page 54: 1D

Saves the current options into the default options file. This file is called **default.rec** or any other name you have assigned to the default options file. Whenever the Teledyne LeCroy PCIe Protocol Suite software begins execution, it automatically loads the default file, if one exists.

Load: See Figure 5.1 on page 54: 1E

Loads a previously saved set of recording options.

OK

Applies changes and closes the Recording Options dialog.

Cancel

Cancels changes and closes the Recording Options dialog.

5.6.2 Loading Recording Options

In the Recording Options menu, you can load a previously saved recording options file.

To load Recording Options:

1. Select **Setup > Recording Options** from the menu.
2. Click the **Load** button from the Recording Options dialog. The Load dialog opens and lists previously saved options files (***.rec**).
3. Select a file and click **OK**. The options file loads.

5.6.3 Saving Recording Options

Recording Options settings can be saved and later reused. Recording options settings are stored in ***.rec** files.

1. Open the Recording Options dialog by selecting **Setup > Recording Options.**
2. Set your options, then click **Save**.
3. Enter a unique file name. The **.rec** extension is added by default.(optional) To add a descriptive label to this file to help you remember what options were set, use the **Options Name** box.

5.7 Recording Type

Recording Type allows you to specify the type of recording you want to make (See Figure Figure 5.1 on page 54: 2A). They are

- Snapshot
- Manual Trigger
- Event Trigger

The recording options available on each analyzer are different. As shown in Figure 5.1 on page 54 the Summit T24 is detected and the recording modes available for it are displayed (See Figure 5.1 on page 54: 2E).

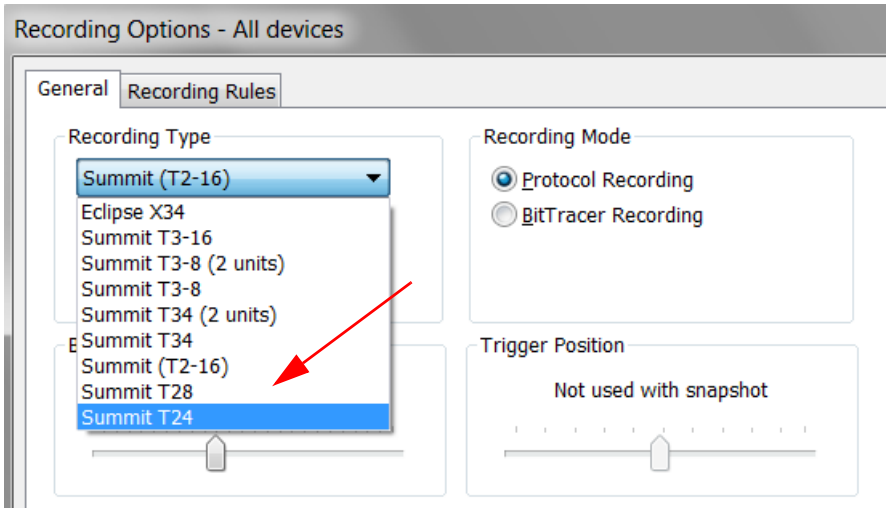


Figure 5.3: Selecting the Target Analyzer

When the analyzer is not yet detected, you can choose the analyzer from the drop-down menu which displays the following:

- **PE*Tracer* Summit**: Displays the options for the PE*Tracer* Summit Analyzer.
- **Summit T28**: Displays the options for the Summit T28 Analyzer.
- **Summit T24**: Displays the options for the Summit T24 Analyzer.
- **Summit (T2-16)**: Displays the options for the Summit T16 Analyzer.
- **Summit T3-8**: Displays the options for the Summit T3-8 Analyzer.
- **Summit T3-8** (2 Units): Displays the same options as Summit T3-8 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2**

are two separate Analyzers linked together.

- **Summit T3-16**: Displays the options for the Summit T3-16 Analyzer.
- **Summit T34:** Displays the options for the Summit T34 Analyzer.
- **Summit T34** (2 Units): Displays the same options as Summit T34 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- **Eclipse X34:** Displays options for the Eclipse X34 Analyzer.

5.7.1 Snapshot

A recording of a pre-determined length. You set the recording length in the Buffer Size box. Recording begins when you click the **Rec** button on the toolbar and ends when the selected buffer size is filled or when you press the **Stop** button.

5.7.2 Manual Trigger

Recording begins when you select Start in the application. Pressing the Trigger button allows the Analyzer to finish recording by switching between the pre-trigger buffer and the post-trigger buffer. Recording continues until the post-trigger buffer has been filled. You can also end the recording immediately by pressing the Stop button in the application.

Note: Consider that when filtering is enabled, pressing the Trigger button will not necessarily cause the post-trigger buffer to fill automatically, due to packets being filtered and not stored. In this case you will have to use the Stop button to immediately end the recording.

5.7.3 Event Trigger

A recording that switches between the pre-trigger buffer and the post-trigger buffer when it is triggered by an event in the CATC Trace. An Event Trigger begins when you select **Start** in the application and ends when the specified triggering event occurs in the CATC Trace or you press **Stop**. If an event triggers the end of the recording, the Analyzer records a predefined amount of post-trigger data (specified by Trigger Position and Buffer Size.)

You can also terminate an Event Trigger recording by pressing the Manual Trigger button on the front of the Analyzer. When the Manual Trigger button is pressed, the Analyzer continues to record until the specified post-trigger buffer has been filled.

5.8 Buffer Size

The Buffer Size allows the Analyzer to record traffic to its buffer and then upload the CATC Trace to the host machine. Recordings are limited in size to the size of the Analyzer's buffer, see Figure 5.1: 2B (1 GB per direction, Upstream and Downstream).

The Buffer Size slide-bar allows you to set the size of the recording buffer.

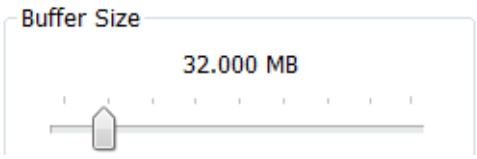


Figure 5.4: Buffer Size Slide Bar

The size selection is per direction. For example, selecting 32 MB creates two memory areas of that size.

After you have set the Buffer Size, you must set the Recording type and Trigger position options. These options determine how the buffer is used.

Note: The Buffer Size slide-bar does not precisely portray the buffer size because of the way the packets are stored in the Analyzer's memory.

5.9 Upload Size

Causes the Analyzer to upload a portion of the Analyzer's buffer. This option lets you look at part of the CATC Trace. Half of the uploaded CATC Trace is pre-buffer and half post-trigger (See Figure 5.1 on page 54: 2C).

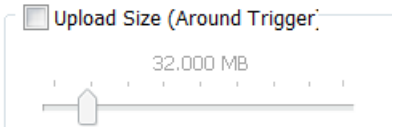


Figure 5.5: Upload Size Slide Bar

5.10 Misc

Turns on trigger beep and tells the Analyzer to use whatever TC to VC mapping was used in the last recording. Click on the Default TC to VC mapping to manually map the Traffic Classes to Virtual Channels (See Figure 5.1 on page 54:2D).

Allows you to specify the following parameters for recording and uploading traffic.

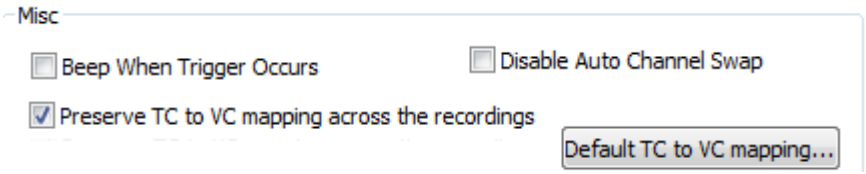

Misc
Beep When Trigger Occurs
Disable Auto Channel Swap
Preserve TC to VC mapping across the recordings
Default TC to VC mapping...

Figure 5.6: Misc Section in Recording Options

- **Beep When Trigger Occurs**: Causes the host machine to beep when a trigger event is detected.
- **Preserve TC to VC mapping across the channels**: Causes the Analyzer to use whatever TC (Traffic Classes) to VC (Virtual Channel) mapping it established in the last recording (to re-use previously discovered Configuration Space data) in all future recordings.
- **Disable Auto Channel Swap**: Prevents the software from determining the traffic flow (upstream or downstream) and reassigning this traffic to its proper direction in the trace.

- **Default TC to VC mapping button**: Lets users manually configure the default mapping.

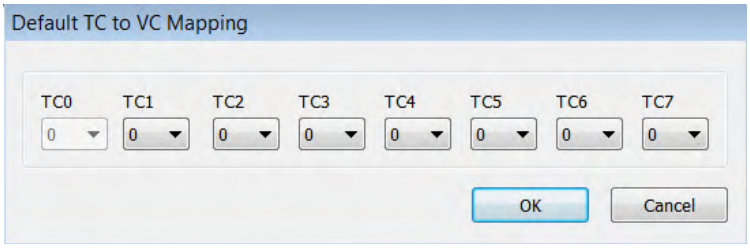


Figure 5.7: Default TC to VC Mapping

5.11 Recording Mode

There are two options for Recording Mode:

- Protocol Recording
- Bit Tracer Recording

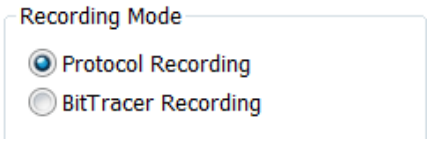


Figure 5.8: Recording Mode Options

5.11.1 Protocol Recording

In this mode of recording, the analyzer records traffic on the bus in a native PCIe protocol.

5.11.2 BitTracer Recording

When the Bit Tracer Recording box is checked, it allows you to select the Speed and the Link Width from the drop-down menu. Based on the Speed and Link Width selected you can select the Upstream and Downstream Symbol on which to trigger.

This option does not have Simple Mode and Advanced Mode. Therefore, Upload Size, the Miscellaneous options, Auto-Configure Lane Polarity, Auto Speed, and Auto Link are not available.

Note: Leaving all the boxes unchecked results in no trigger in that direction. For more information, see the next chapter, see the next chapter, “BitTracer Recording” on page 191.

5.12 Trigger Position

This Trigger Position slide-bar lets you adjust the amount of recording buffer allocated to recording pre-trigger and post-trigger traffic (see Figure 5.1 on page 54: 2F).

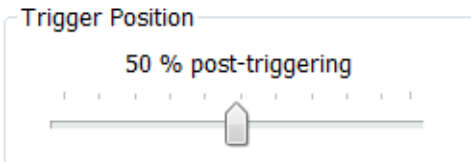


Figure 5.9: Trigger Position Slide Bar

For example, if you set the Trigger Position to 90% Post-Triggering Traffic, the Analyzer records 10% pre-trigger traffic and 90% post-trigger traffic.

Trigger Position is only available when Manual Trigger or Event Trigger is selected.

5.12.1 Viewing Legacy Multi-Segmented CATC Traces

Current PCIe Protocol Suite software handles traces as large as the maximum buffer size selected. It does not need to generate segmented traces, but is able to open segmented traces generated with older software versions. Simply open the *.pem extension file and the trace will be converted to a new format single trace. If you are opening a *.pex file part of a segmented trace, make sure not to update the file in order for the original segmented index to work properly.

5.13 Link Settings

The Link options panel allows you to manage links (see Figure 5.10 on page 62). You can define the basic link parameters or leave it on Auto detect. The various link settings are described in this section (see Figure 5.1 on page 54: 3).

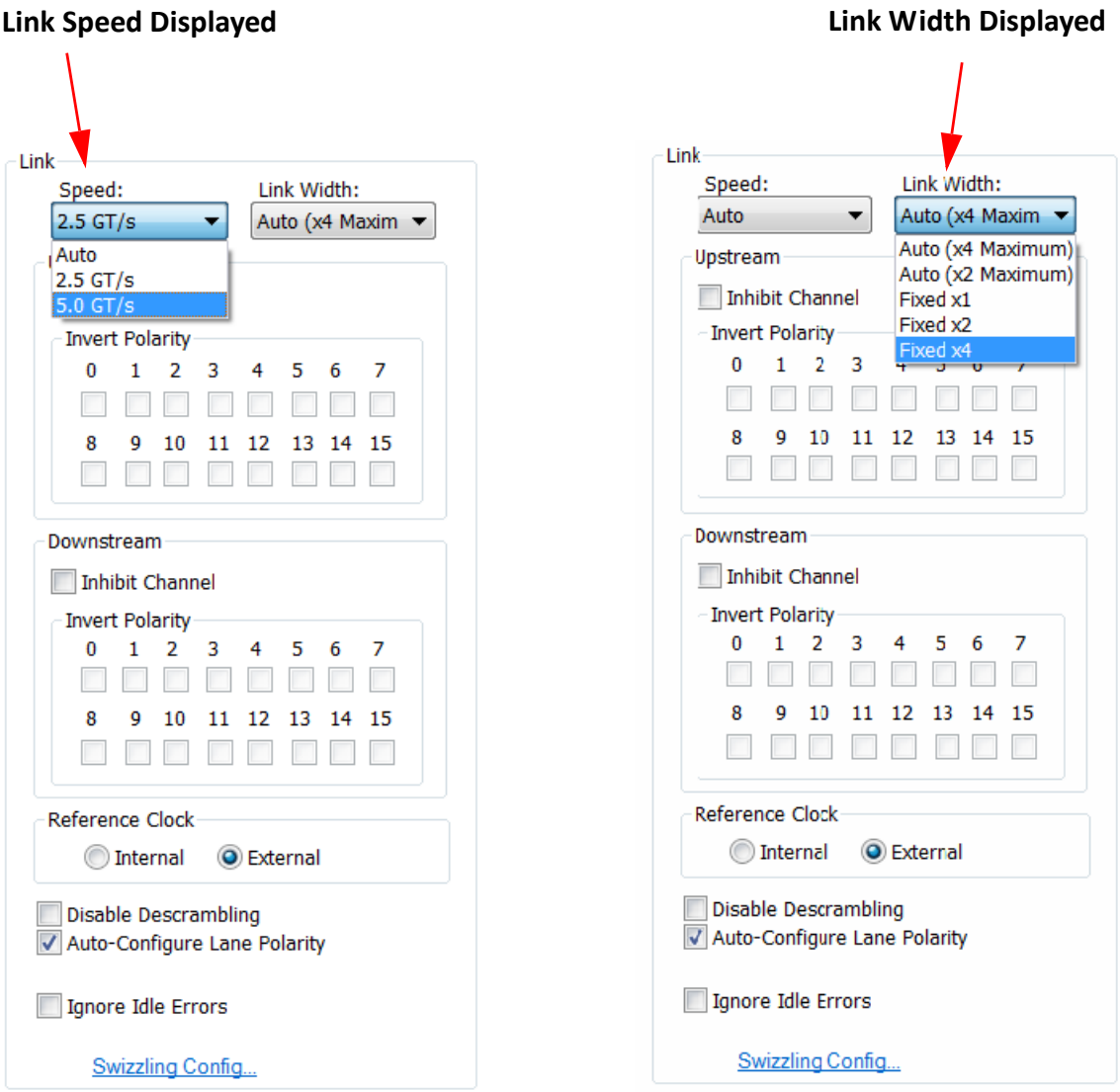


Figure 5.10: Link Options for Summit T24

5.13.1 Speed

The Speed can be set at Auto, 5.0 GT/s, or 2.5 GT/s from the drop-down menu. The default is Auto (see Figure 5.1 on page 54: 3A or Figure 5.10 on page 62 left side).

Auto: When set to Auto, the hardware auto-determines the speed.

5.0 GT/s or 2.5 GT/s: When set to a specific speed, Teledyne LeCroy's software forces the hardware to record at that speed.

For Auto speed setting to work the polarity setting of lane 0 has to be correct. The polarity can be set manually if the link is already in L0 state, or, for automatic polarity detection, the bus has to go through a reset so the analyzer can track the polarity.

Note: For certain build configurations speed option 5.0 GT/s may be disabled.

Note: Selecting Auto in the Speed drop-down list will set the correct speed even if the analyzer does not record a link training sequence.

5.13.2 Link Width

The Link Width sets the physical width of the link. Select the Link Width or select **Auto** (see Figure 5.1 on page 54: 3B or Figure 5.10 on page 62 right side). The available options (and the default) will be shown according to the detected product.

Auto Max X4	Calculates link width automatically up X4
Auto Max X2	Calculates link width automatically up X2
Fixed X1	Link is assumed to be always X1
Fixed X2	Link is assumed to be always X2
Fixed X4	Link is assumed to be always X4

Note: If the bus goes to a link width different from the one selected as fixed option, the trace will be full of errors. The appropriate Auto option needs to be selected in this case.

Note: Selecting Auto in the Link Width drop-down list will find the correct link width even if the analyzer does not record a link training sequence and for links that are in low power states.

5.13.3 Upstream and Downstream

Gives you low-level control over each link direction. The heading for these boxes indicates the port and/or unit to which the following options are applied based on the current Analyzer configuration (see Figure 5.1 on page 54: 3C and 3D).

- **Inhibit Channel: Do not record/upload this channel**
- **Reverse Lanes: Reverse Lanes: Manual lane reversal. If Swizzling Config is set, the Reverse Lanes will not work if Auto is checked.**
- **Invert Polarity**

5.13.4 Reference Clock

If the PCI Express link under analysis uses spread-spectrum clocking, then the Analyzer must use the external reference clock from the system. If the Device Under Test does not supply a reference clock, the internal reference clock in the Analyzer module can be used instead (see Figure 5.1 on page 54: 3E). Only the standard PCIe reference clock is supported.

5.13.5 Disable Descrambling

If checked, causes the Analyzer to assume that none of the PCI Express traffic is scrambled. By default, the Analyzer determines the scrambling state of the devices under test (see Figure 5.1 on page 54: 3F).

5.13.6 Auto-Configure Lane Polarity

Lets the Analyzer determine lane polarity (see Figure 5.1 on page 54: 3G). Auto functions such as Auto Configure polarity rely on Gen1 or Gen2 training sequences to properly discover their values.

5.13.7 Ignore Idle Errors

When set the analyzer will not store errors in between packets in the memory. This option helps to preserve analyzer memory to store more packets in cases where memory efficiency is critical. This option can also be used to filter out Compliance Patterns (see Figure 5.1 on page 54: 3H).

5.13.8 Swizzling Config...

The Swizzling Config dialog allows you to reconfigure the order of the US (UpStream) and DS (DownStream) lanes. See Figure 5.1 on page 54: 3I.

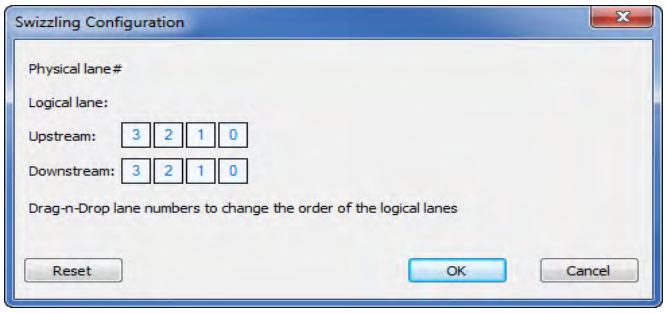


Figure 5.11: Swizzling Config Dialog

When the Auto-Configure Lane Swizzle is checked, it is important to configure Lane 0. You can do so by manually dragging Lane 0 to the required position (see Figure 5.12 on page 65).

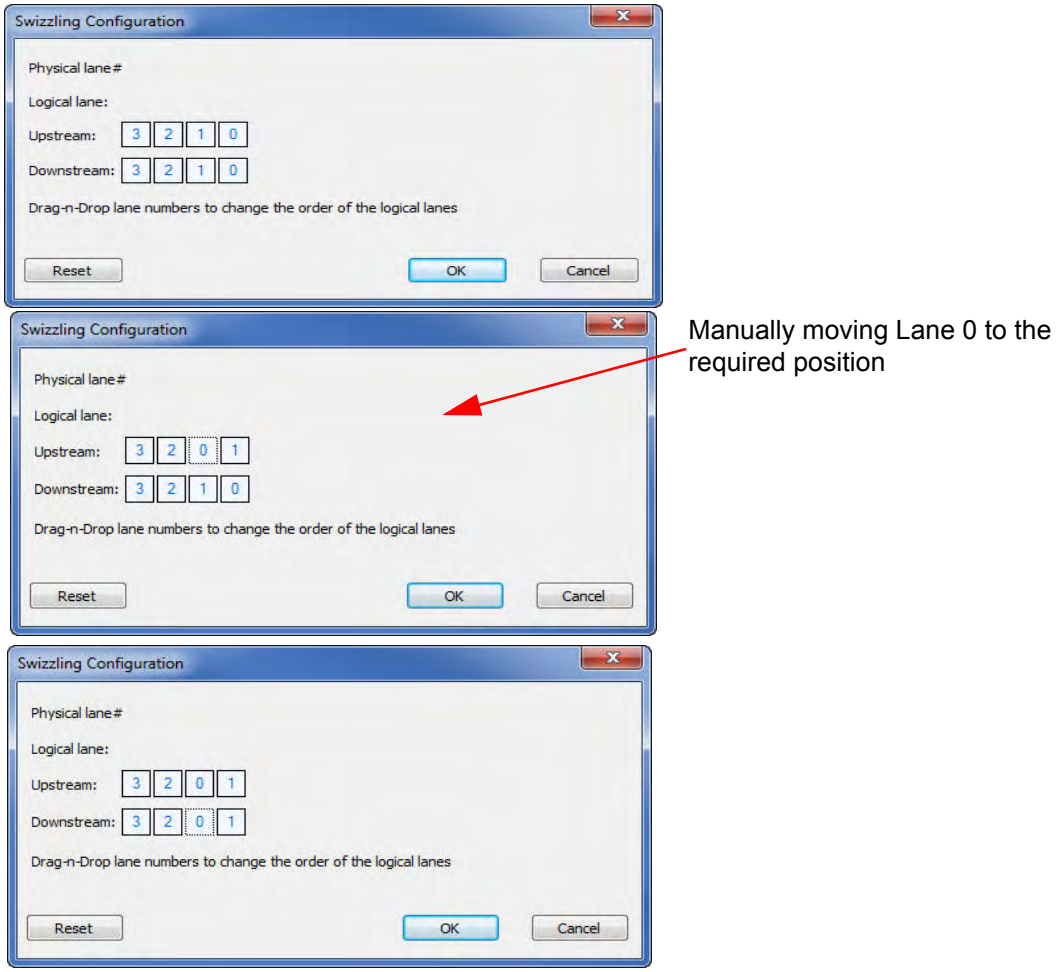


Figure 5.12: Manually Configuring Lane 0

5.14 Triggering

Triggering Options can be set in both Simple and Advanced Modes. The options in both modes are the same, only the GUI is different where shortcuts for the events are displayed in the Simple Mode for easy access (see Figure 5.2 on page 55).

In the Advanced Mode triggering is set up via the recording rules which allow greater flexibility to create advanced sequences you would like the analyzer to look for. These recording rules are not available in the Simple Mode. The Simple Mode allows you to simply define triggering by checking the boxes.

Note: Ensure that the correct analyzer is selected for the right options.

5.14.1 Triggering On (Simple Mode)

You can check any of the boxes shown in Table 5.1 for Trigger On in Simple Mode (see Figure 5.13 on page 67).

TABLE 5.1: Simple Mode Trigger On Events

CLKREQ#	Config
WAKE#	Memory
Switch to G1	IO
Switch to G2	Message
Switch to G3	RD Error
Link Width Change	Invalid Symbol
TS1	Block Align Error
TS2	Token Error
InitFC1	Idle Symbol Error
NAK	

Trigger Position is only available when Event Trigger or Bit Tracer Recording is selected.

Note: If you check 2 boxes or more the triggering will occur based on an OR condition, not AND condition.

Note: External Input Trigger is not configurable, it will always cause the analyzer to trigger on a toggle when using manual trigger or triggering on any event.

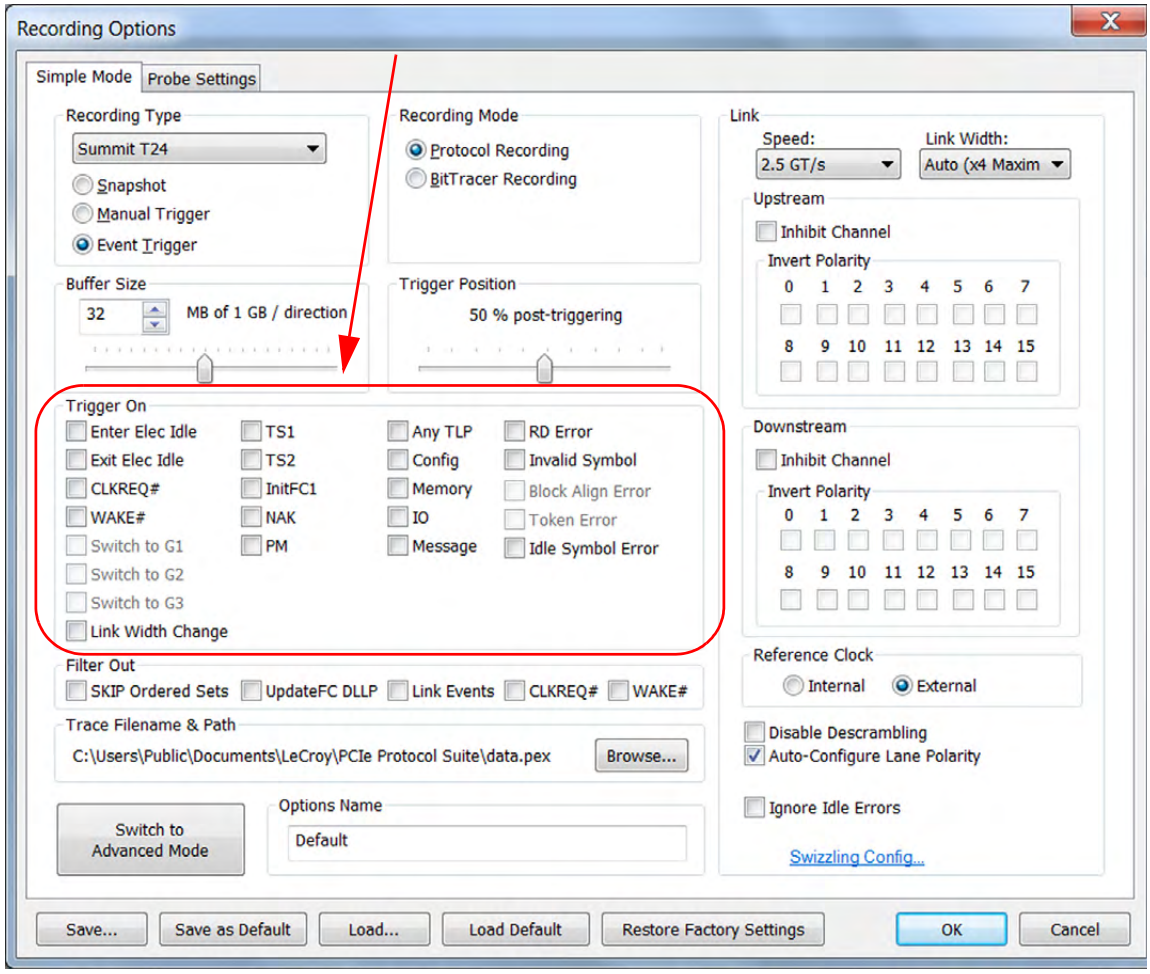


Figure 5.13: Simple Mode Triggering Options

5.14.2 Triggering On (Advanced Mode)

The same triggering options are available in the Advanced Mode as in the Simple Mode. The Advanced Mode gives you additional flexibility to drill down and configure these options in greater detail via the Recording Rules dialog.

In the Advanced mode click on the Recording Rules tab to configure the settings. As shown in Figure 5.14, the Recording Rules tab allows you to create New Events. For each event you can create Actions. A detailed explanation of the Recording Rules is given in the following sections.

Note: External Input Trigger is not configurable, it will always cause the analyzer to trigger on a toggle when using manual trigger or triggering on any event.

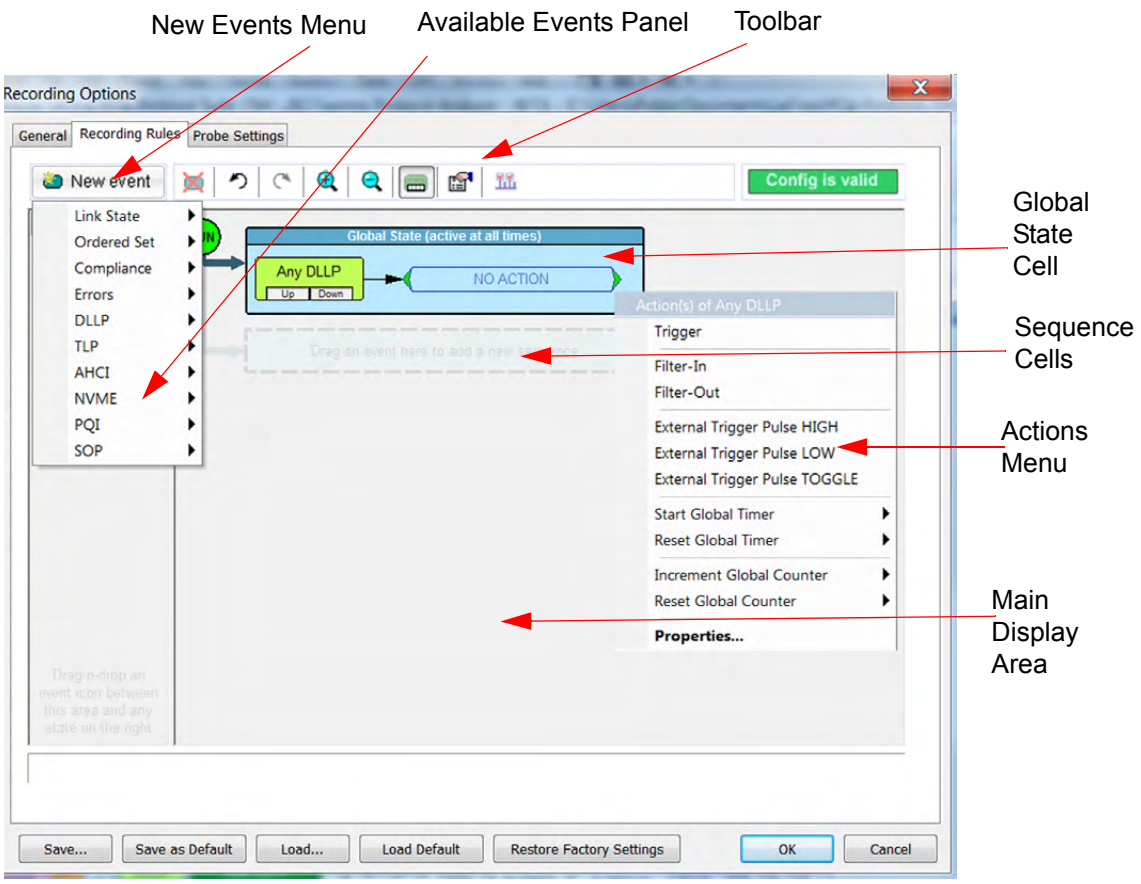


Figure 5.14: Recording Rules Tab

5.15 Navigating Recording Rules

The Recording Rules window has three main areas, the Toolbar, Available Events panel and the Main Display panel (see Figure 5.14 on page 68).

5.15.1 Toolbar

The toolbar contains buttons such as the New Events button for issuing commands, Delete Current Event, Undo, Redo, Zoom in and out, Show/Hide Channels and Properties.

5.15.2 Available Events Area

The Available Events area is in the left repository panel where you can park buttons that you intend to use in the Main display area. The events in this panel do not affect the recording. You can drag and drop events in the Main Display panel.

5.15.3 Main Display Area

The Main Display area is the right panel where you create trigger and filter conditions. You create conditions by dragging buttons onto the Main display area from the Available Events area. You then create additional conditions by right-clicking a button and selecting options from a pop-up menu. See Creating Recording Rules.

5.15.4 Recording Rules Buttons

The Recording Rules toolbar allows you to create and edit recording rules:

TABLE 5.2: Recording Rules Toolbar Buttons

New event	New Event. Opens a drop-down menu with a list of events.		Zoom out
	Delete. Delete selected event.		Show/Hide Channels. Shows/ hides the channel buttons.
	Undo. Undoes last action.		Show properties. Opens the Properties dialog for the selected item.
	Redo. Undoes last Undo command.		Lane Trigger Configuration: Sets lane pre-conditions for event categories.
	Zoom in		

5.16 Recording Rules Overview

The Recording Rules allows you to specify complex triggering and filtering options. The Summit T24 monitors incoming traffic and looks for specified events. It performs actions like triggering and filtering. Complex options can be created by putting Events in a sequence.

Events are based on Resources (see “Resources” on page 72).

5.16.1 Defining Recording Rules

The Recording Rules page is used to set triggers and filters. To access this page, select **Setup > Recording Options > Recording Rules**.

You can also access the New Event menu by right-clicking in the blue space in the Global State or in the Sequence State (see Figure 5.15 on page 70).

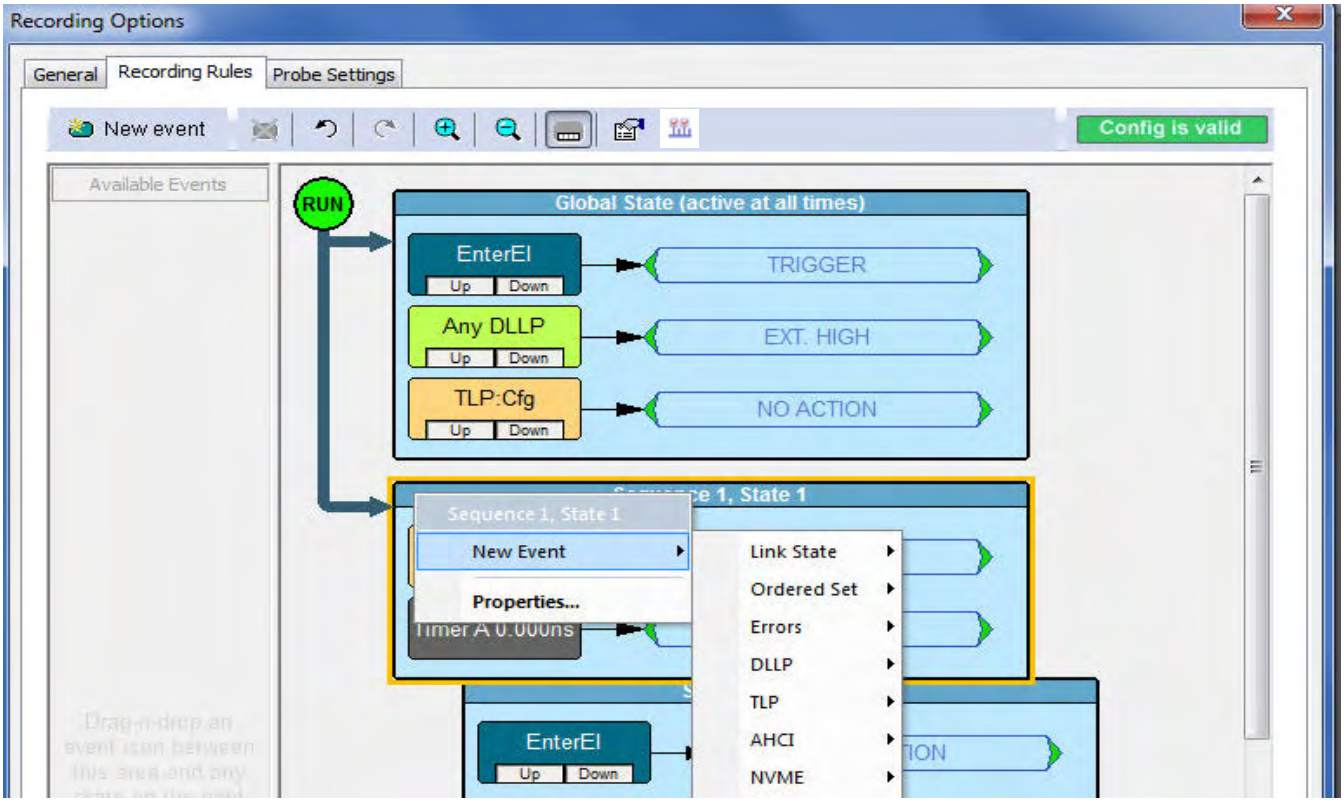


Figure 5.15: Defining New Events

There are three steps to creating a recording rule:

1. Select events.
2. Place the events in the Global State or Sequence cells.
3. Assign actions to the events.

Note: There are limits to the types of rules that can be created.

1. Click New event and select one or more events from the menu (see Figure 5.16 on page 71). Selecting an event automatically places it in the Available Events area. This repository area serves as a parking lot where you can place event buttons without them having any effect on the Analyzer.

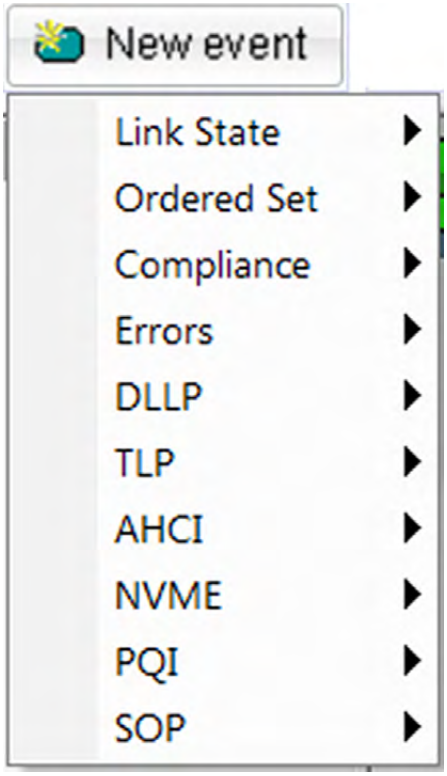


Figure 5.16: New Event

2. Drag the selected events from the Available Events area into either the Global State Cell or the Sequence Cell (see “Recording Rules Overview” on page 69).

Global State Cell

If you want the Analyzer to always search for the event, place it in the cell marked **Global State**.

Sequence Cell

To create an event sequence, place two or more events in the faintly marked cell that reads **Drag an event here to add a new sequence**. At this point, the selected events have no effect because an action has not been assigned.

3. To select a sub-set of your selected event, right-click it and choose **Properties**. A Properties dialog opens that presents additional options. For example, if you open the Properties dialog for Errors, you can set the specific types of errors the Analyzer should look for.
4. Assign an action to the selected events by right-clicking each of the events, selecting **Specify Action** from the pop-up menu, and assigning an action such as **Trigger,**

Filter, or **Count**. Be sure to click the event itself and not the **State** cell that it is sitting in (which displays a different pop-up menu) (see Figure 5.17 on page 72).

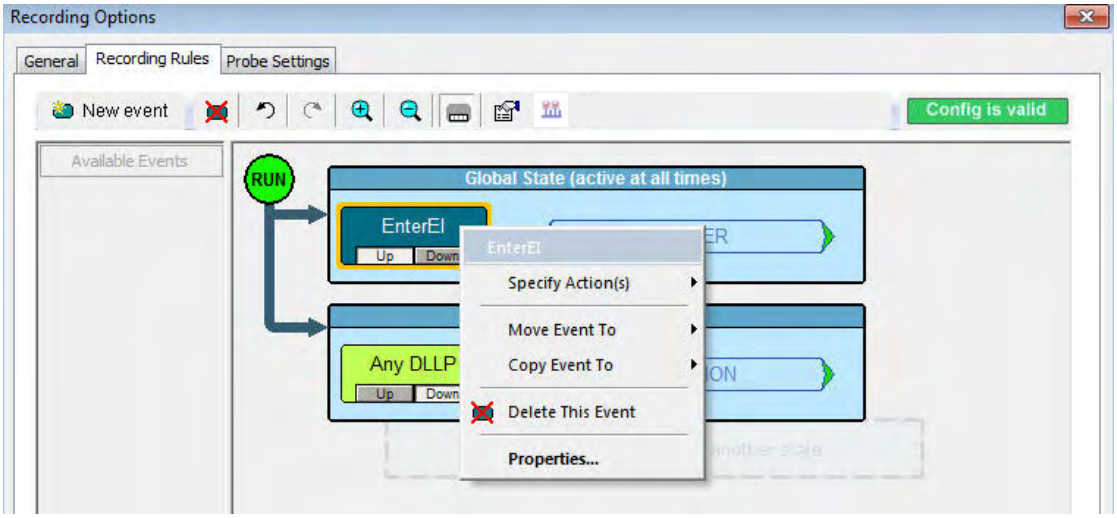


Figure 5.17: Assigning an Action

Note: You can also assign actions to events by double-clicking the event or action and selecting the Actions page when the Properties dialog opens (see "Event Properties Dialog Box Features" on page 82).

5. Click **OK** to close the dialog. At this point, assuming that the other options in the Recording Options dialog have been set (such as the General page), you can begin the recording by pressing the

   Start **Recording** button.

5.17 Resources

Events in Recording Rules are based on Resources. There are two types of Resources. They are Packet Match Resources, and Basic Resources.

5.17.1 Packet Match Resource

Packet Match Resources are for the TLP, DLLP, TS1 and TS2 events as well as some of the storage protocol trigger options such as AHCI Register, NVMe Register, PQI Register and SOP IU Type. A Packet Match Resource allows you to define not only packets but it also allows you to define each specific bit in a packet. In the Packet Match resource you can define the exact layout to the bit level so that the Analyzer can match the exact pattern that applies to a TLP, DLLP, TS1 or TS2 event.

To set a Packet Match Resource, click on the **New Event** button and select any of the options. In this case we have selected **DLLP: InitFC1**. The **DLLP: InitFC1** displays in the **Available Events** panel. Double-click on the **DLLP: InitFC1** to select the specific fields and go to the Layout tab to change the pre-defined bits.

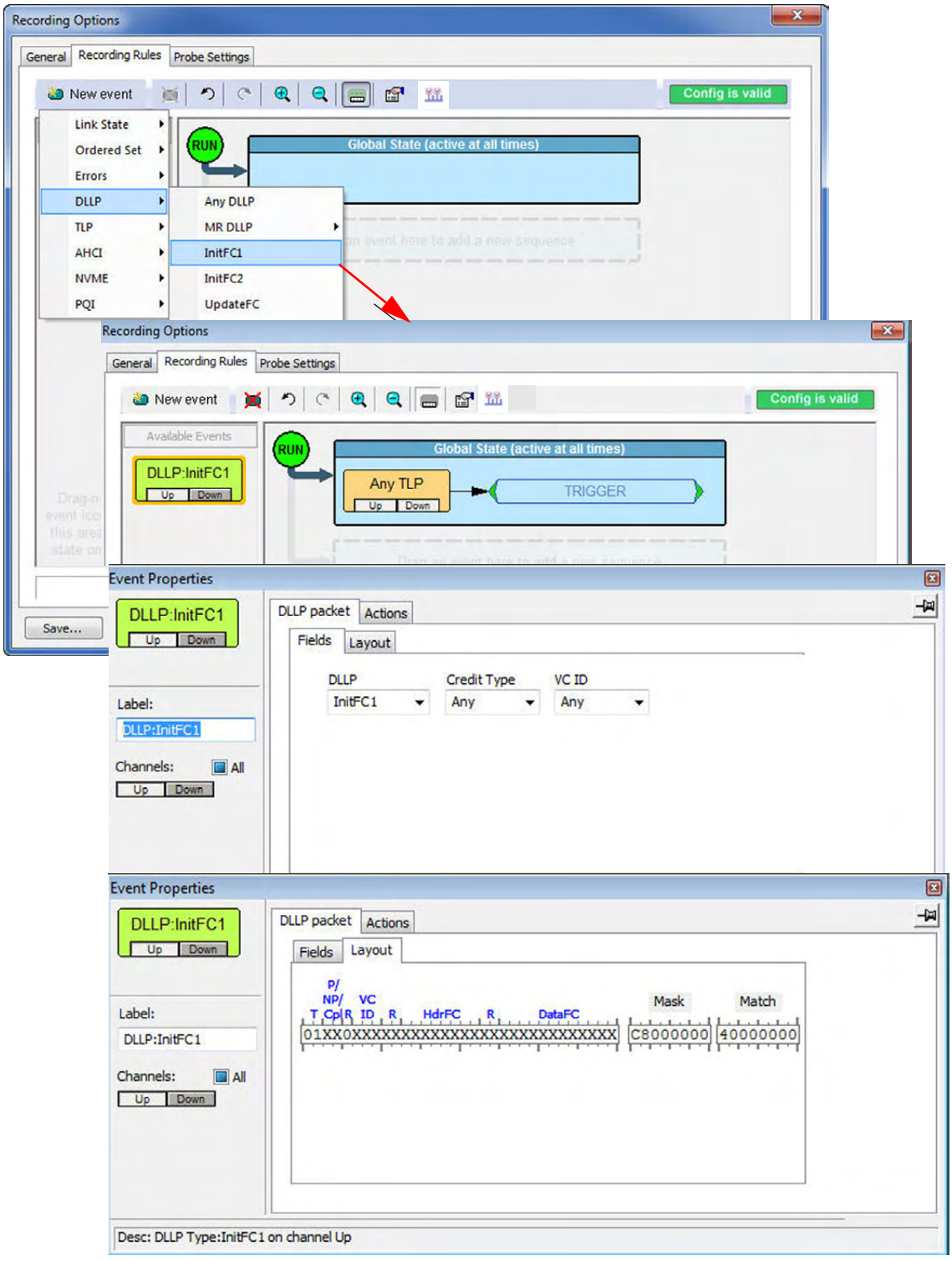


Figure 5.18: Setting Up a Packet Match Resource - DLLP.

To set a TS1 Packet Match Resource, click on the **New Event** button and select **Ordered Set: TS1**. The **Ordered Set: TS1** displays in the **Available Events** panel. Double-click on the **TS1** to select the specific fields and go to the Layout tab to change the pre-defined bits.

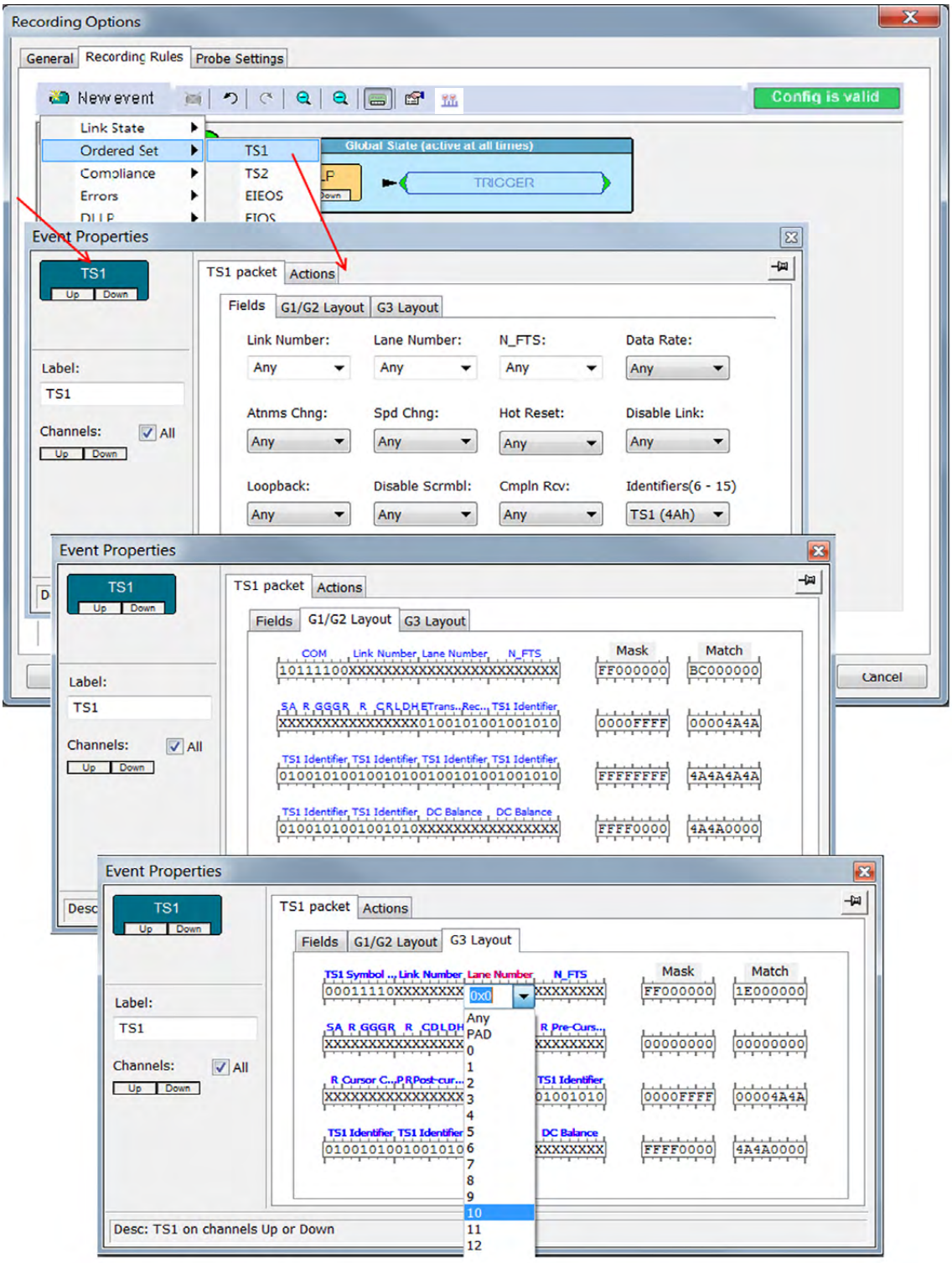


Figure 5.19: Setting Up a Packet Match Resource - TS1.

Defining Gen3 Layout tab does not mean the that analyzer will trigger on a TS that happens just at Gen3. Gen3 Layout will allow you to define the bits but if these bits are matched at any other speed the analyzer will trigger.

5.17.2 Basic Resource

Basic Resources are for the Link States, Ordered Sets (except TS1 and TS2) and Errors. A Basic Resource does not allow you to define patterns to the bit level. It just matches events that have been predefined.

To set a Basic Resource, click on the **New Event** button and select any of the options. In this case we have selected **Ordered Set: TS1**. The **EIEOS** displays in the **Available Events** panel. Double-click on the **EIEOS** to select other Ordered Set events and go to the Actions tab to configure specific Actions (see Figure 5.20 on page 76).

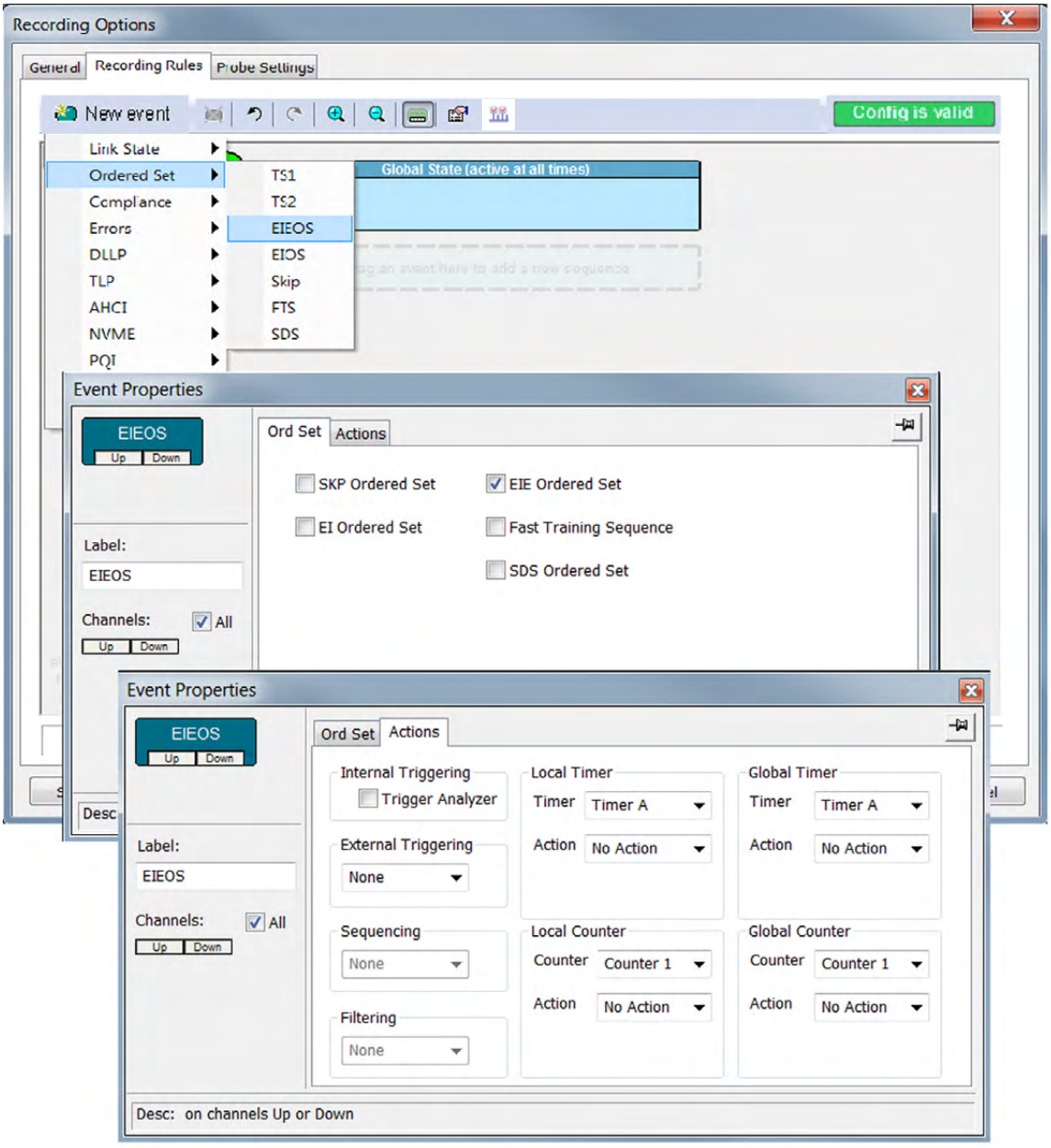


Figure 5.20: Setting Up a Basic Resource

5.18 Global State and Sequence States

The Main Display area in the center of the Recording Rules window has two cells that affect events differently, they are the Global State and Sequence State.

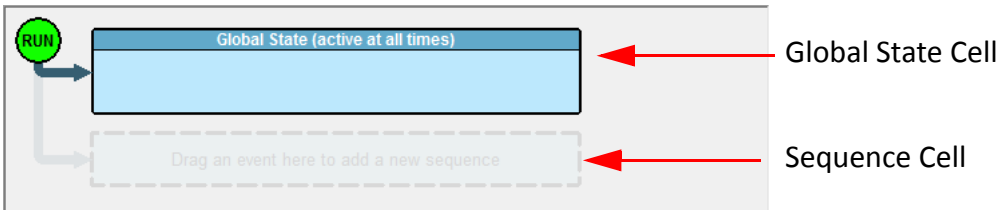


Figure 5.21: Global State Cell and Sequence State Cell

In the Global and Sequence State you can add events by clicking on the New Event button and after the event is in the State you can right-click to Specify Actions, Move, Copy or Delete the event. You can view the Properties dialog to make additional changes to the Property of the event (see Figure 5.14 on page 68). The description of these actions are given in Table 5.4 on page 90.

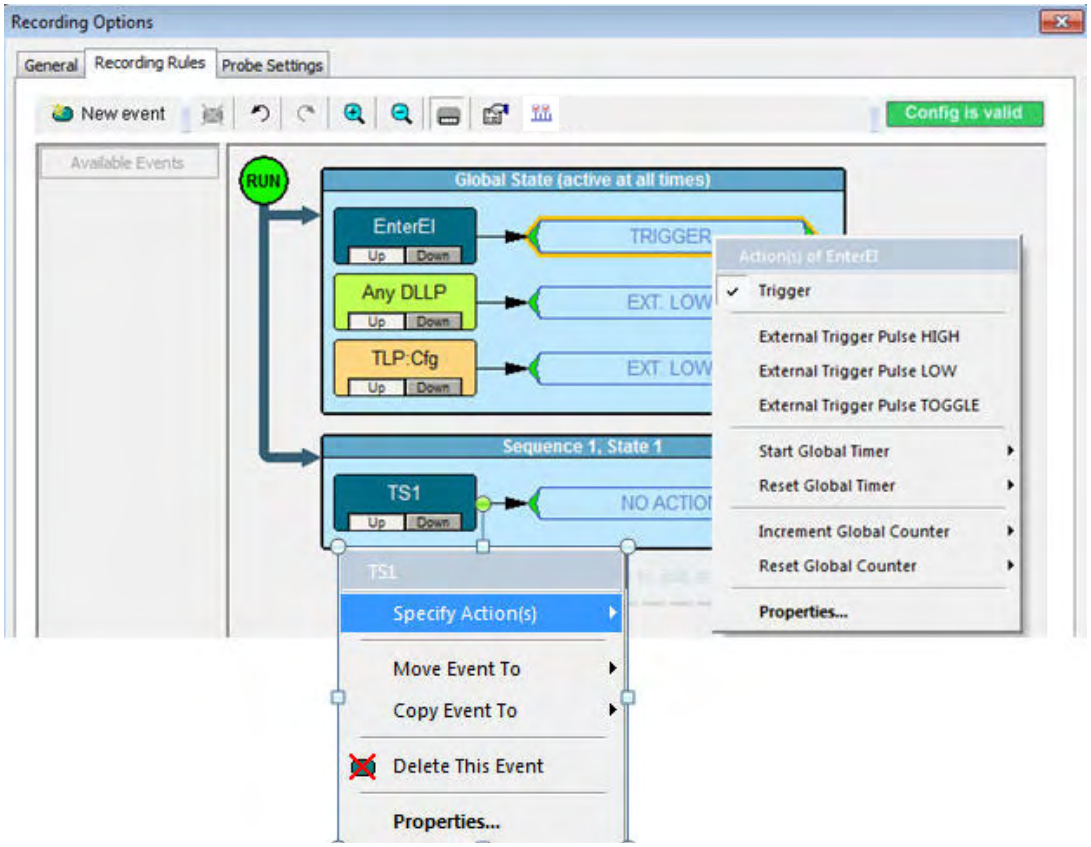


Figure 5.22: Global State Menu

5.18.1 Global State

The Global State is active all the time. The Summit T24 Analyzer tracks all the Events and Actions defined in the Global State throughout the recording. In the Global State the Link

State, Ordered Set (except TS1 and TS2), Errors, Counter and the Timer use Basic Resources while TLP, DLLP, TS1 and TS2 use Packet Match Resources. The Global State has two Timers and two Counters.

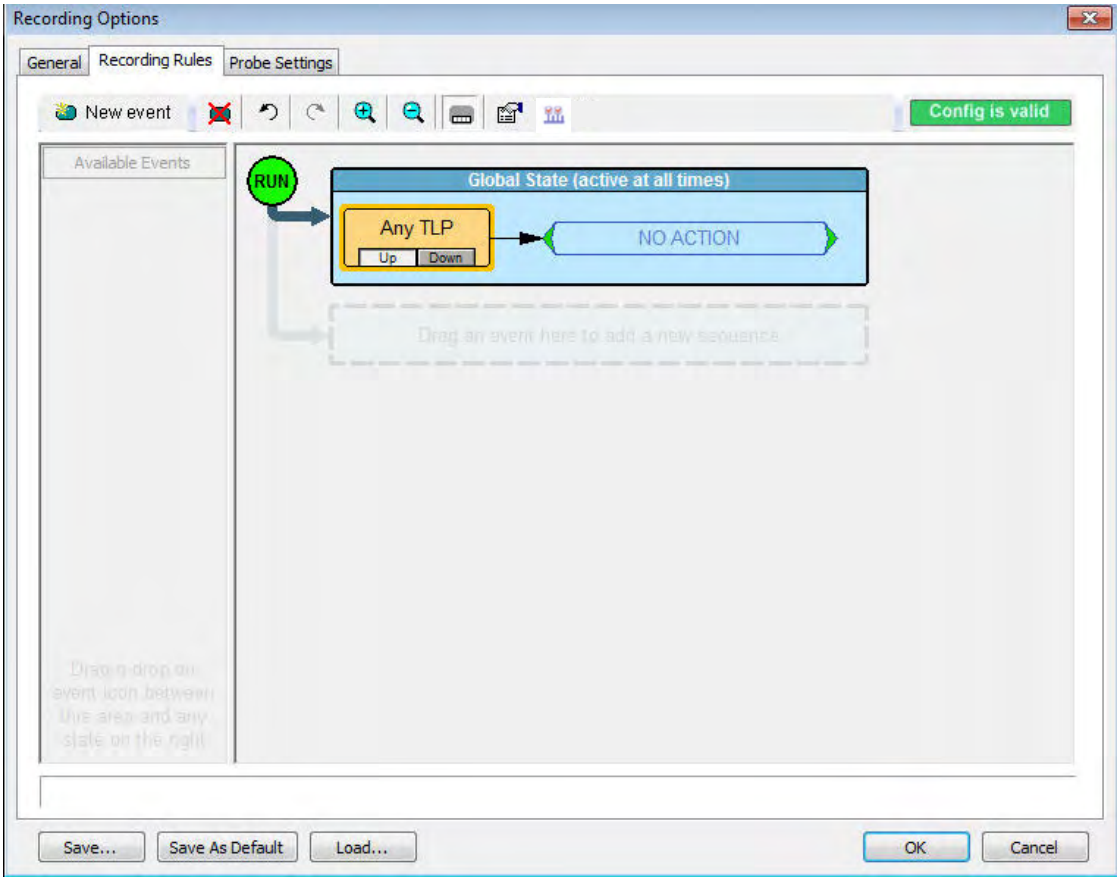


Figure 5.23: Global State

For the Global State there are only 2 Basic Resources for each Channel. Some optimization is done internally to accommodate additional resources. You can keep adding resources to the Global state so long as the **Config is valid** button stays green. If you add a new event which is not valid a window appears with a message prompting **Invalid Recording Rules Configuration** and the **Config is valid** button will turn red (see Figure 5.24 on page 79).

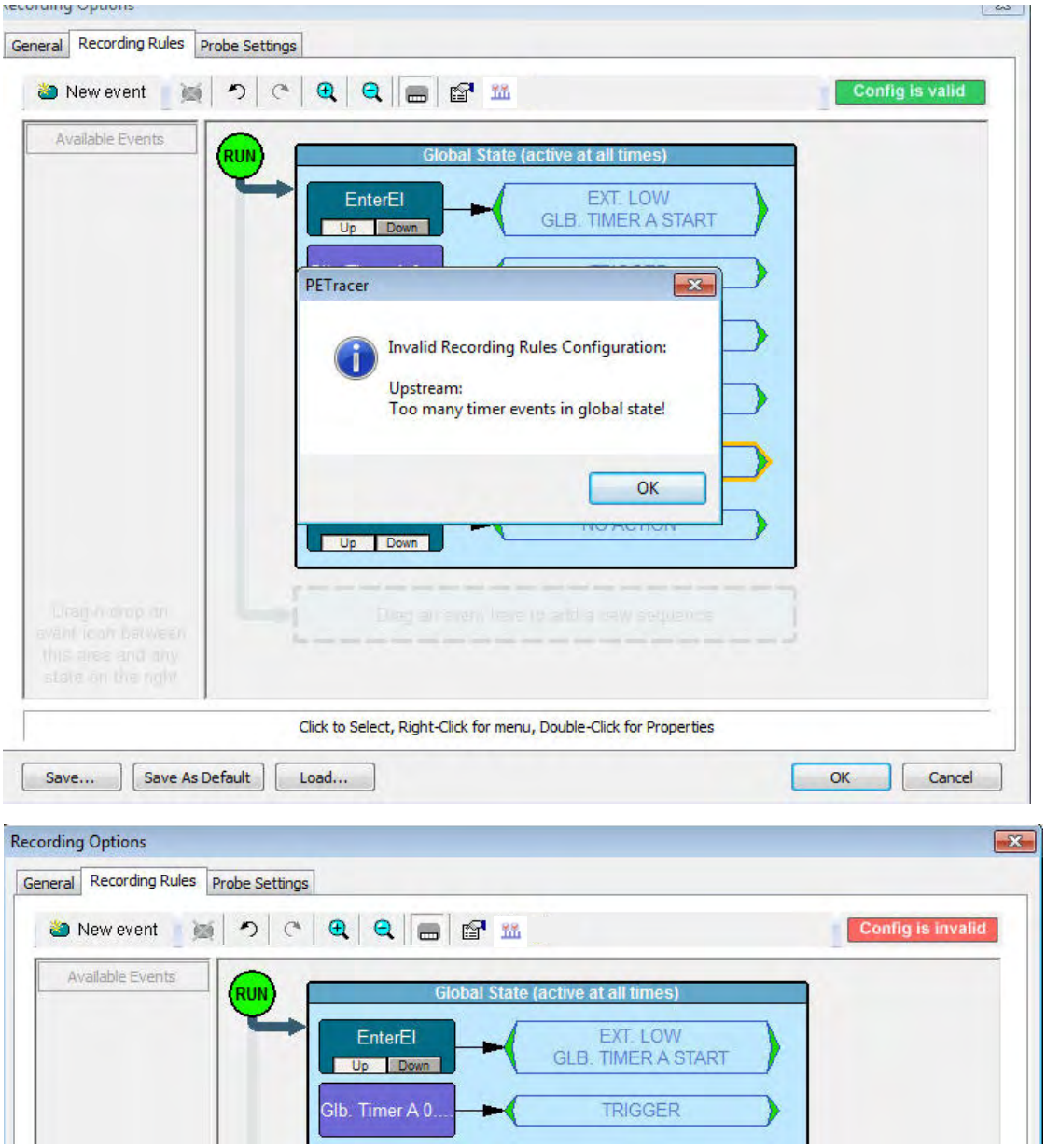


Figure 5.24: Valid and Invalid Recording Rules Configuration Dialogs

5.18.2 Sequence State

The cell marked **Drag an event here to add another sequence** is the Sequence State. In the Sequence State you can define a sequence of Events and Actions which the Summit T24 Analyzer looks for at pre-determined times. Sequences are chains of events culminating in a trigger or any other action. A sequence which is a separate chain of events can be created with up to 16 states. A state is an event condition with an action within a sequence. Once a Sequence State is added the cell marked will read **Drag an event here to add another state** (see Figure 5.25 on page 80).

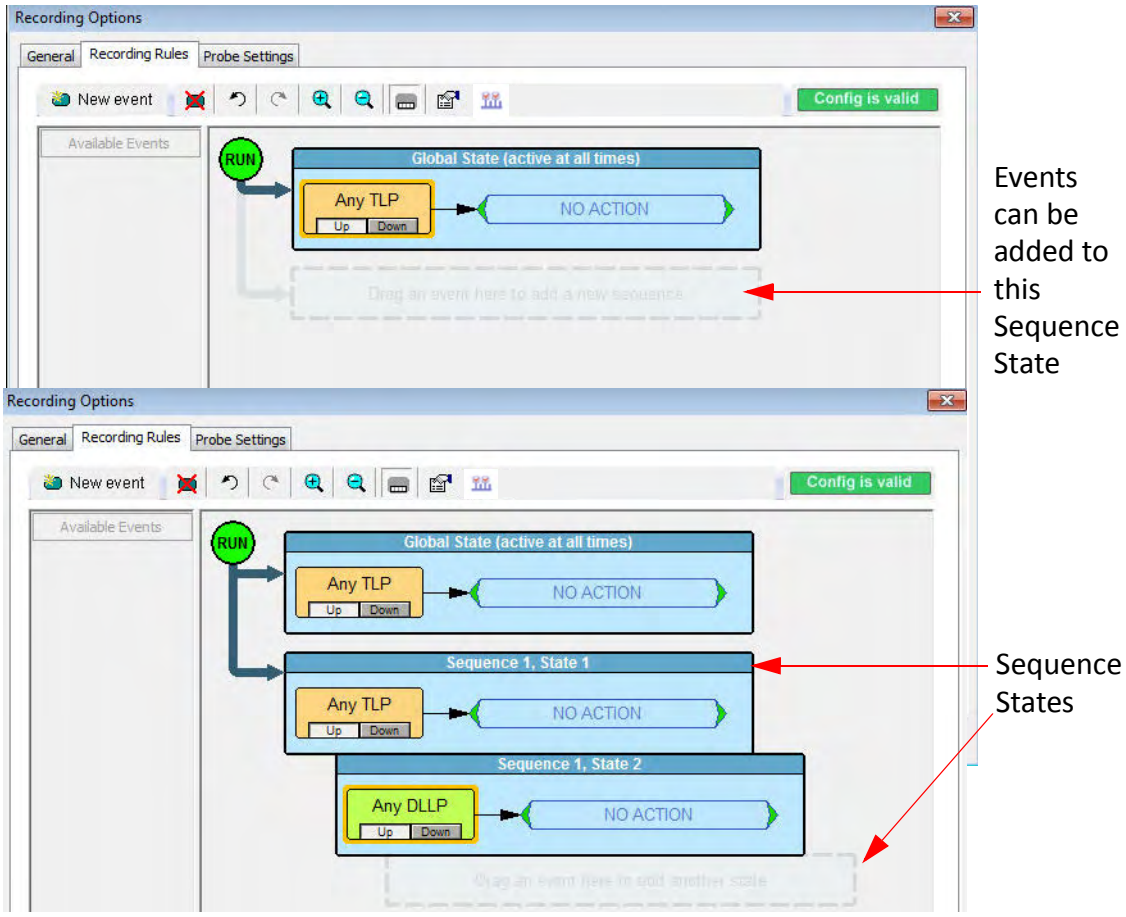


Figure 5.25: Sequence State Events

In the Sequence State the Link State, Ordered Set, Errors, Counter and the Timer use Basic Resources while DLLP and TLP use Packet Match Resources. There are four Timers and four Counters in the Sequence State.

Note: In each Sequence State up to six Basic Resources and six Packet Match Resources can be defined.

5.19 Recording Rules Events

There are nine sets of Events that can configured and actions can be set for every Event..

TABLE 5.3: Events and Event Actions

Event	Pre-Defined Event Actions
Link State	
	Enter Electrical Idle
	Exit Electrical Idle
	Speed Switch to 2.5Gb/s

TABLE 5.3: Events and Event Actions (Continued)

	Speed Switch to 5.0Gb/s
	Speed Switch to 8.0Gb/s
	CLKREQ# Asserted
	CLKREQ# Deasserted
	WAKE# Asserted
	WAKE# Deasserted
Ordered Set	
	TS1
	TS2
	EIEOS
	EIOS
	Skip
	FTS
	SDS
Compliance	
	Gen1 / Gen2
Errors	
	Idle Error
	Disparity Error
	Symbol Error
	Token Error
	Block Align Error
DLLP	
	Any DLLP
	MR DLLP (MRInit, MRReset, MRUPdatFC, MRInitFC1, MRInitFC2
	InitFC1
	InitFC2
	UpdateFC
	ACK
	NAK
	Power Management
	Vendor
TLP	
	Any TLP

TABLE 5.3: Events and Event Actions (Continued)

	Config Rd
	Config Wr
	IO Rd
	IO Wr
	Mem Rd
	Mem Wr
	Message
	Completion
AHCI	
	AHCI Register
NVME	
	NVME Register
PQI	
	PQI Register
SOP	
	SOP IU Type

5.20 Properties Dialog Boxes for Events

Properties dialog boxes provide additional settings for Events, States, and Actions in the Recording Rules page. You can access a Properties dialog by double-clicking an **Event, State, Action** or any other object. It allows you to set triggers and filters. For example, to set a trigger on a specific type of error, you open the Properties dialog.

5.20.1 Accessing the Properties Dialog

To see the Properties dialog, first create an event button by clicking the **New Events** button and choosing an event from the menu. Open the Event Properties dialog by doing one of the following:

- Double-click an event.
- Right-click an event and select **Properties** from the pop-up menu.
- Click the **Properties** button on the toolbar.

5.20.2 Event Properties Dialog Box Features

The following features are displayed in the any Event Properties dialog box (see Figure 5.26 on page 83).

Event Icon Preview

This icon shows you which event properties you are editing. The Icon Preview looks exactly like the icon in the Main Display area.

Icon Label

A text box for labeling the button. Whatever you type here appears on the button.

Channels

These controls allow you to select the channel(s) that the Analyzer should search when it is looking for the event.

Pin Button

The Pin Button on the top right corner of the dialog allows you to **pin** the Properties dialog to the application so that it does not go away when another object appears such as an event, state or action.

Description String

This area contains a textual description of the event.

Event-specific Settings

The largest part of the Event Properties dialog. The settings in this area vary for different events. Some events do not have any additional settings.

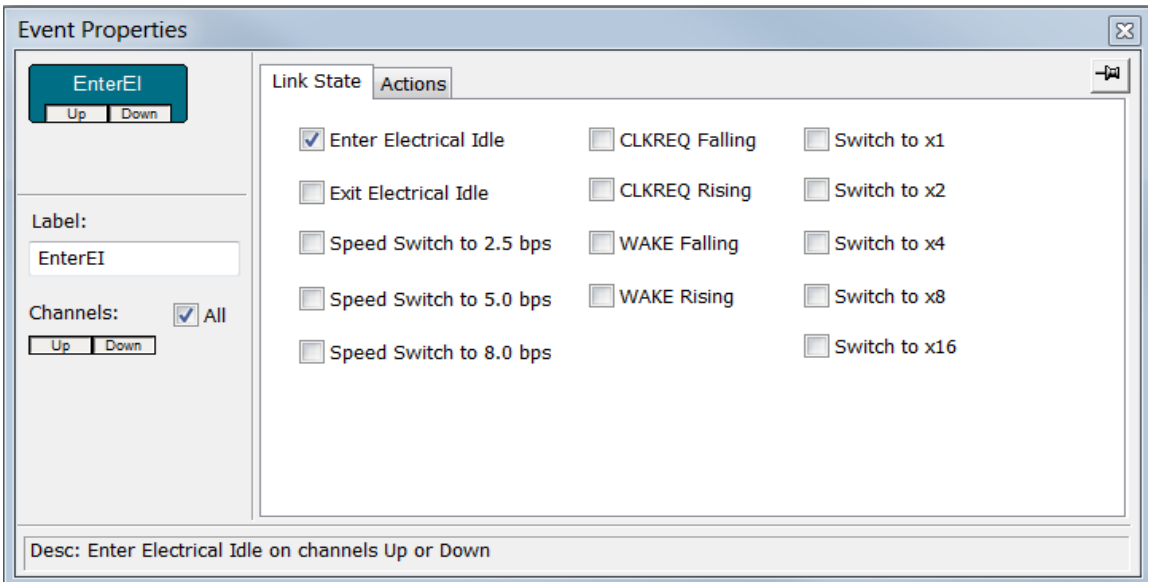


Figure 5.26: Properties Dialog Box

5.20.3 Link State Dialog

The Link Properties dialog lets you select the link state.

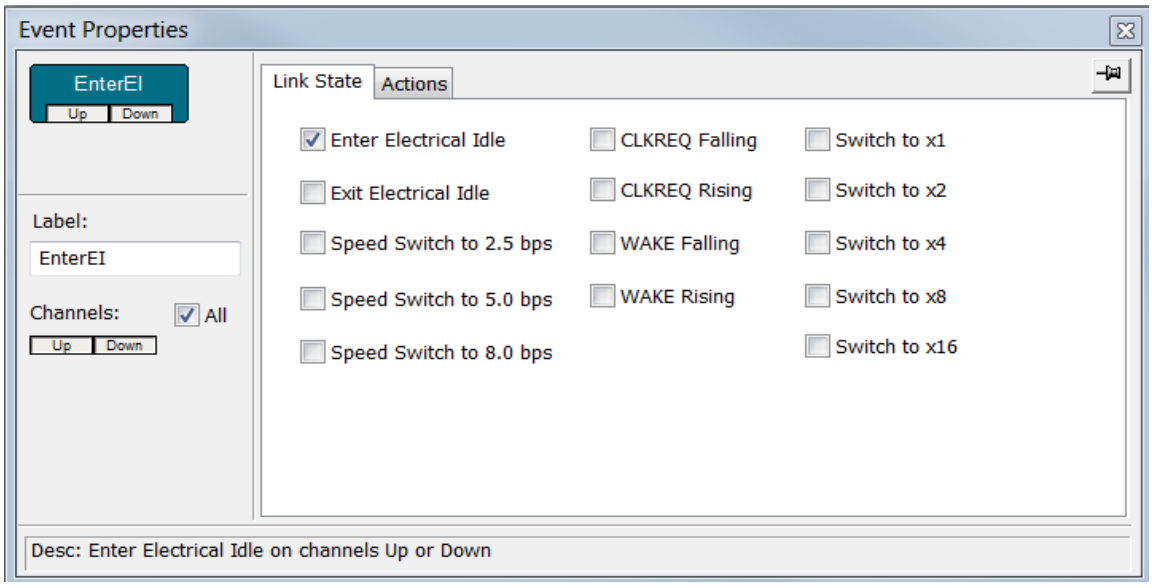


Figure 5.27: Link State Properties Dialog

5.20.4 Ordered Set Properties Dialog

An Ordered Set cannot be filtered in a Global State, but can be filtered in a Sequence State.

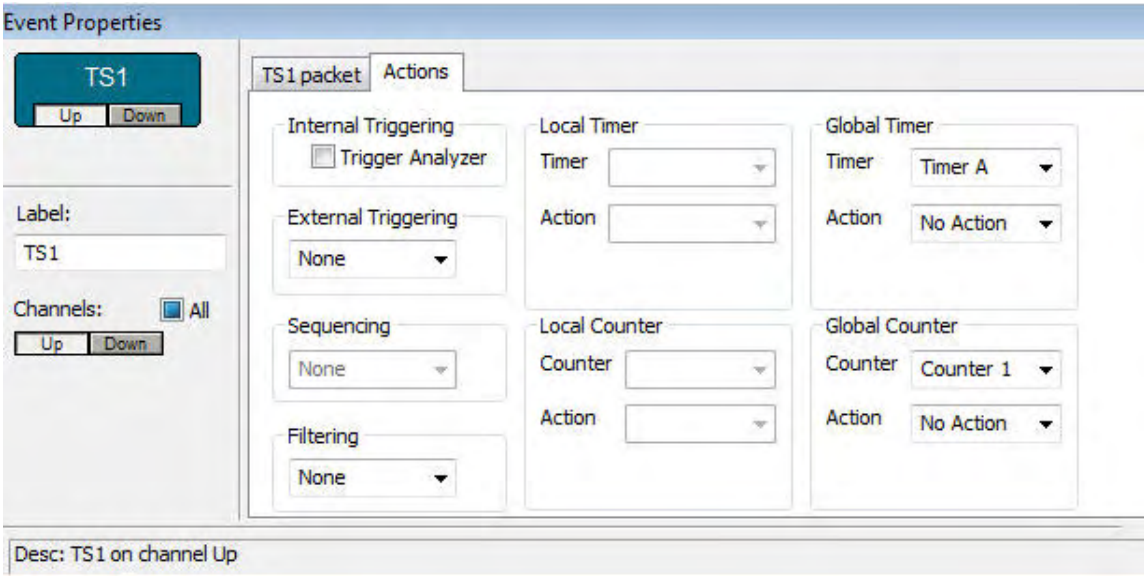


Figure 5.28: Ordered Set Properties Dialog

5.20.5 Error Properties Dialog

The Error Properties dialog lets you select specific error types for performing an action. There are two sets of Error types: Packet Errors and Idle Errors.

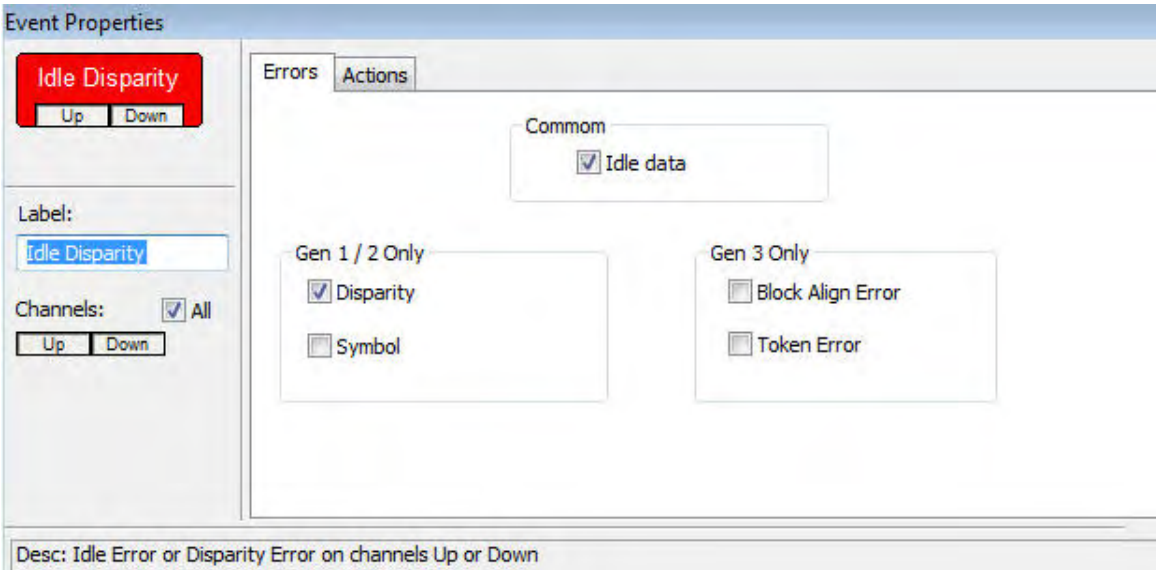


Figure 5.29: Error Properties Dialog

5.20.6 DLLP Packet Properties Dialog

The DLLP Packet Properties dialog allows you to specify any DLLP field as shown below.

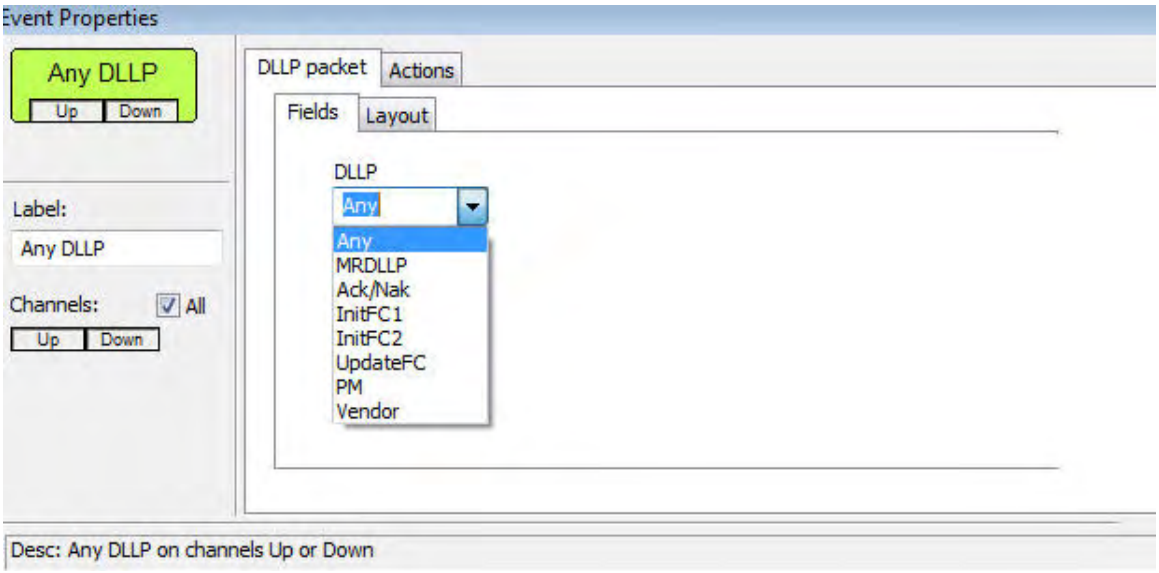


Figure 5.30: DLLP Packet Properties Dialog

The Layout tab of the DLLP Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below.

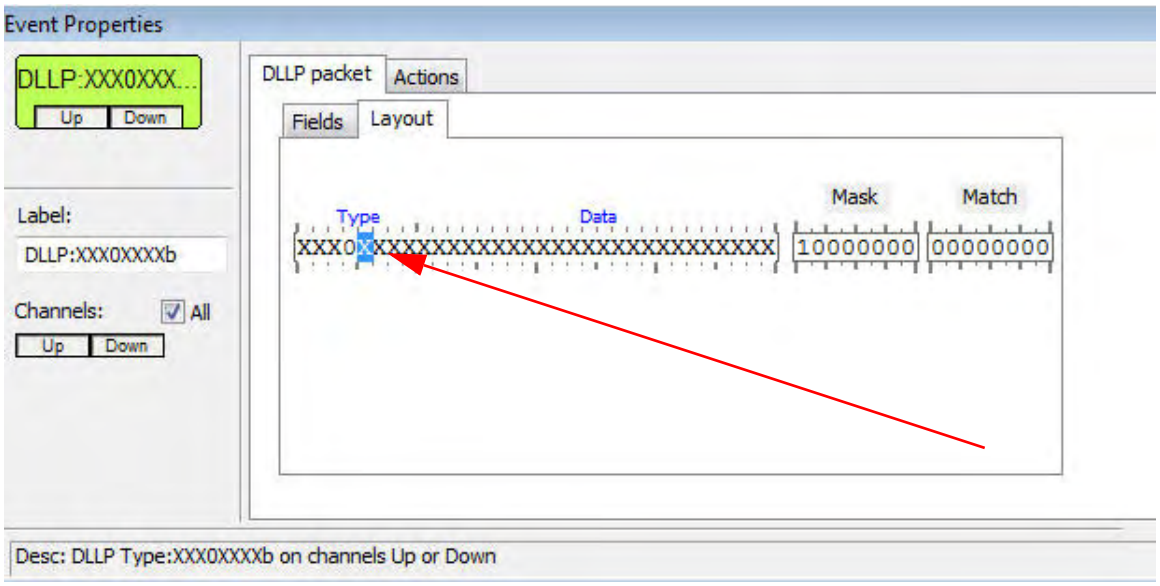


Figure 5.31: DLLP Packet Properties Dialog

5.20.7 TLP Header Properties Dialog

The TLP Header Properties dialog enables you to set the TLP Header Fields and Layout, TLP Prefixes and Actions. You can manually change the Requester/Completer ID.

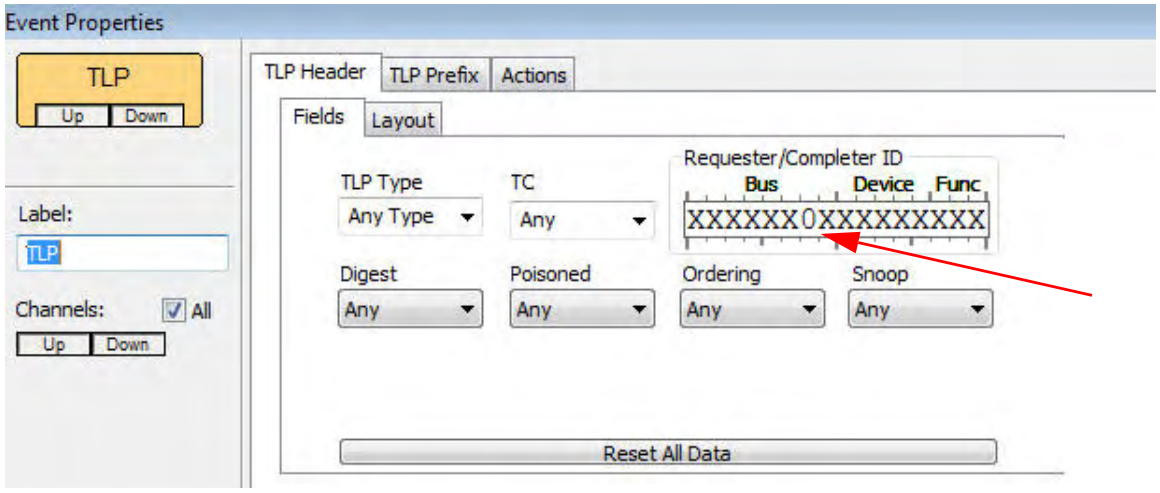


Figure 5.32: TLP Header Properties Dialog

5.20.8 TLP Prefix Properties Dialog

The Layout tab of the TLP Prefix Packet Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below.

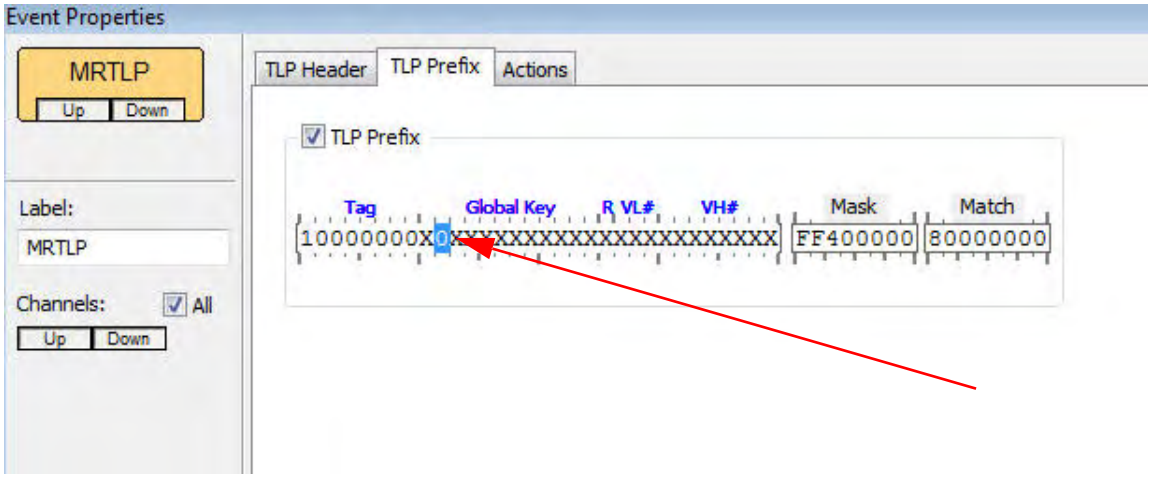


Figure 5.33: TLP Prefix Properties Dialog

5.20.9 AHCI Register Properties Dialog

The AHCI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset.

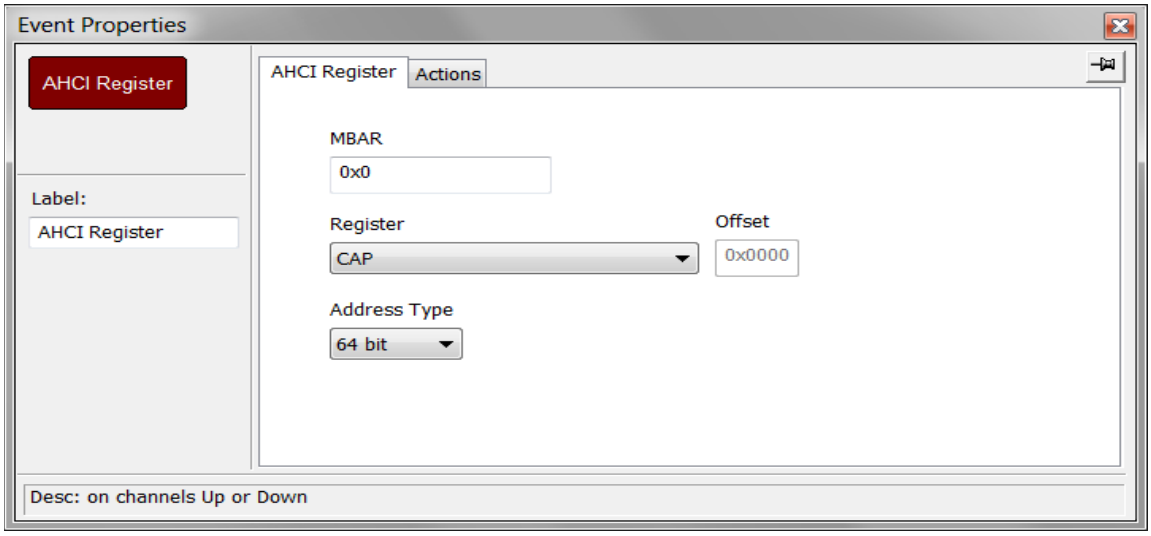


Figure 5.34: AHCI Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.20.10 NVME Register Properties Dialog

Any of the NVMe Register options can be selected from the New Event list. The NVME Register options are shown in Figure 5.35.

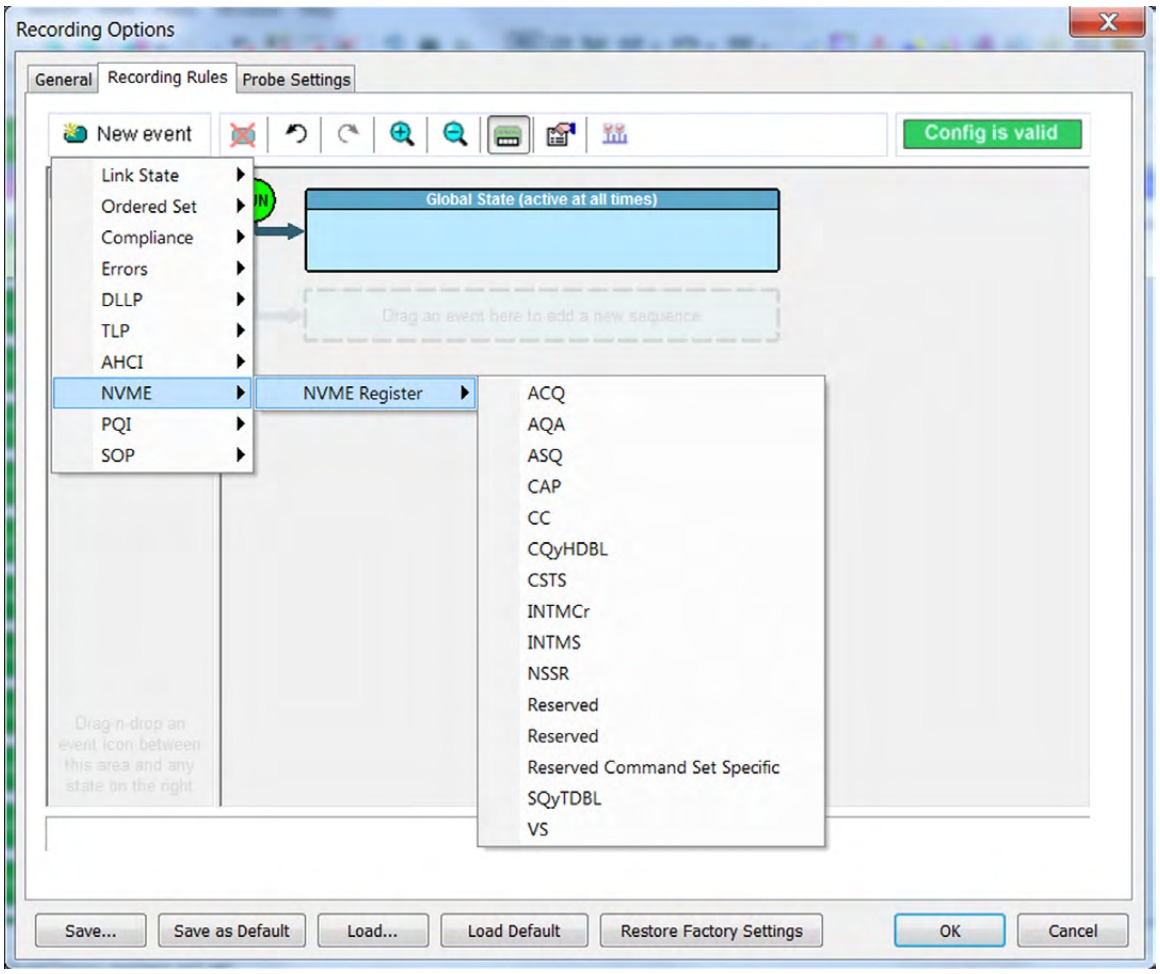


Figure 5.35: NVME Register Options Dialog

The NVME Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset.

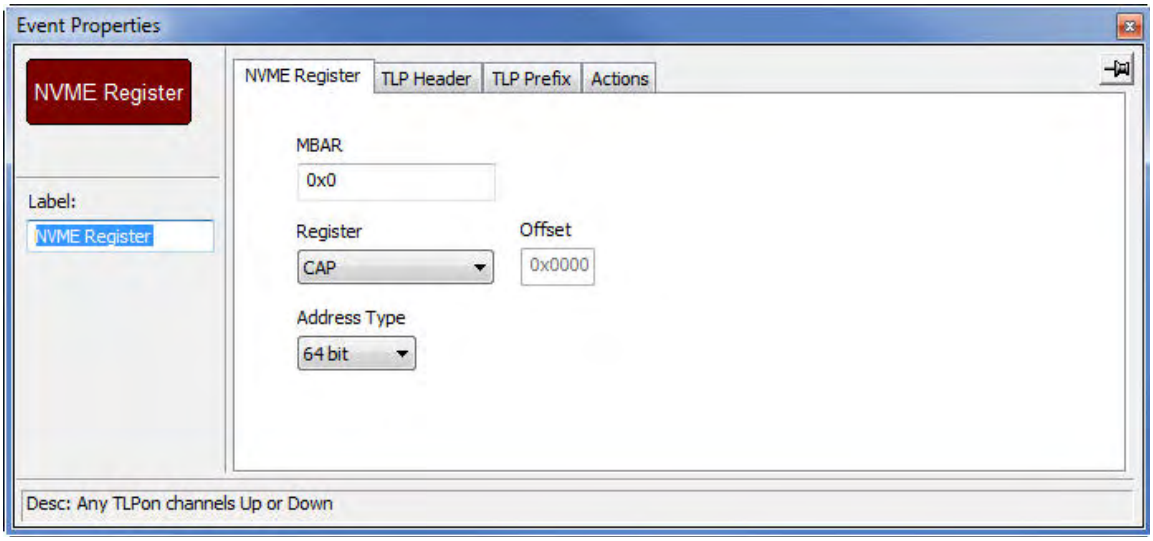


Figure 5.36: NVME Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.20.11 PQI Register Properties Dialog

The PQI Register Properties dialog allows you to enter the MBAR value, choose the Register and Address Type from the drop-down list and enter the offset.

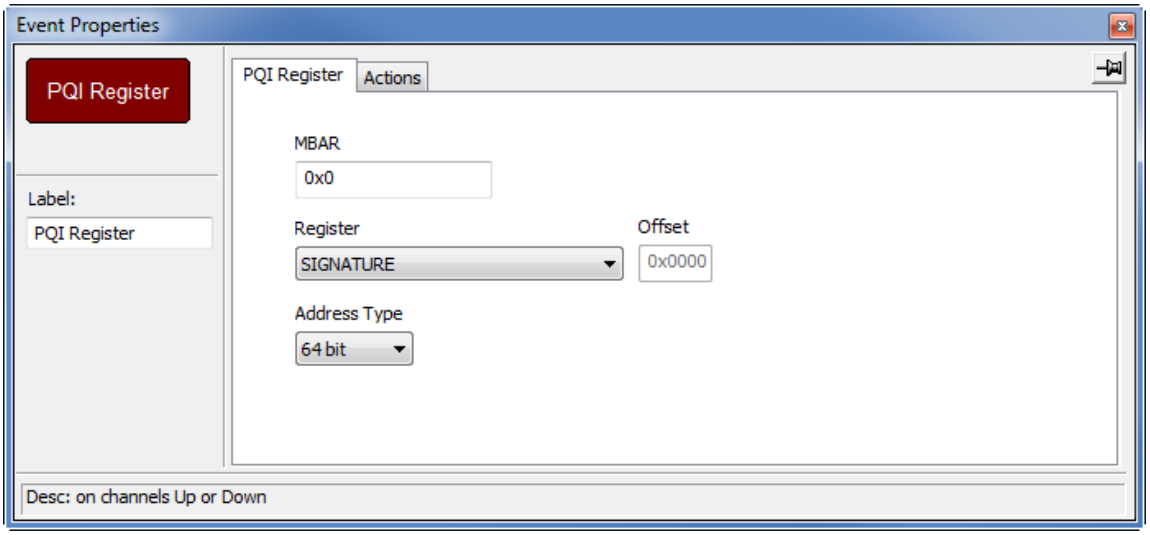


Figure 5.37: PQI Register Properties Dialog.

Note: Triggering on register event with 32-bit address and payload defined is applicable to register write transactions only.

5.20.12 SOP IU Type Properties Dialog

The SOP IU Type Properties dialog allows you to change the pattern and customize it by defining each specific bit as shown in the figure below.

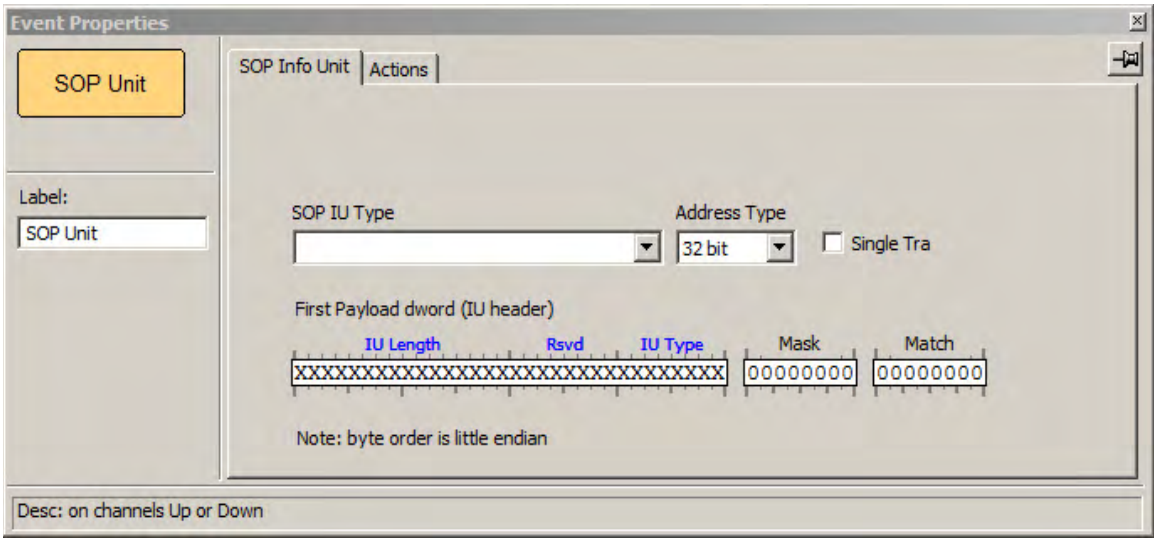


Figure 5.38: SOP IU Type Properties Dialog.

5.20.13 Actions Properties Dialog

Every Event has an Action tab as shown in Figure 5.39 on page 91.

The following tables describes the Actions for each Event.

TABLE 5.4: Event Actions

Action	Description
Label	Label the action.
Channels	Select Channels to go upstream or downstream.
Internal Triggering	Check the box to enable Internal Triggering from the Trigger In input. Any edge of the supplied signal will cause the analyzer to trigger. For Trigger In from MicroD cable (see“MicroD to CATC Sync Cable” on page 16).
External Triggering	Set the External Triggering to Low, High or Toggle. The default is None. For Trigger Out from MicroD cable (see“MicroD to CATC Sync Cable” on page 16).
Sequence	Set the Sequence to Advance. The default is None.
Filtering	Set the Filtering to Filter Out. You cannot Filter In in the Summit Z3-16. The default is None.
Local Timer	Set the Local Timer, there are four options available.
Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it’s initial value. The default is No Action.
Local Counter	Set the Local Counter, there are four options available.

TABLE 5.4: Event Actions (Continued)

Local Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.
Global Timer	Set the Global Timer, there are two options available.
Global Timer Action	You can set the Action of the timer to Start or Reset. When you reset the timer it resets to it's initial value. The default is No Action.
Global Counter	Set the Global Counter, there are two options available.
Global Counter Action	You can set the Action of the Counter to Increment or Reset. The Counter increments by one and resets to its initial value. The default is No Action.

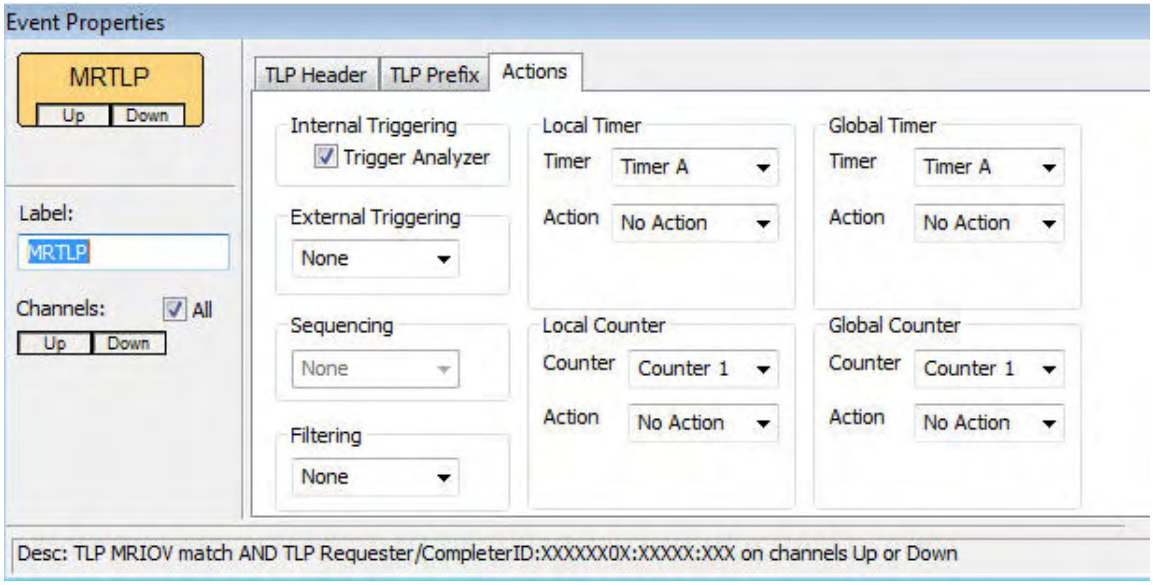


Figure 5.39: Actions Properties Dialog.

5.21 Filter Out

A filter causes the Analyzer to filter out specified events from the recording. If events are filtered out of the recording, they are excluded from the Analyzer's buffer and not simply hidden from the CATC Trace. The purpose of “filtering out” is to preserve recording memory so you conduct longer recording sessions and exclude events that do not interest you.

Filter-Out In Simple Mode

In Simple Mode you can filter out:

- SKIP Ordered Sets
- UpdateFC DLLP
- Link Events (Link Up and Link Down)
- CLKREQ#
- WAKE#

You can also choose to Ignore Idle Errors. See Figure 5.40.

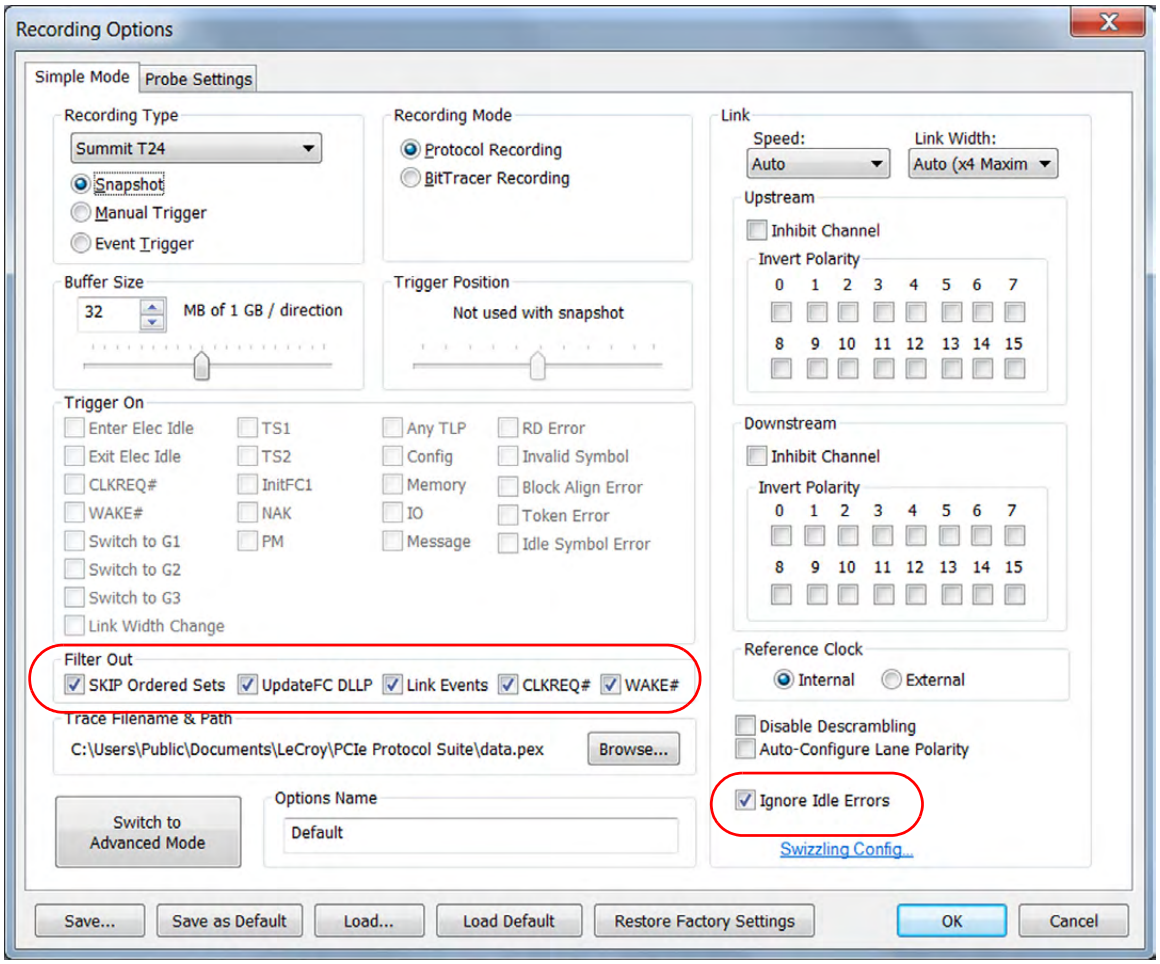


Figure 5.40: Simple Mode: Filter Out

Note: If you did Filter-Out all the events shown above, you'd create an empty trace and get a warning message (see "Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed." on page 182.)

Filter-Out in Advanced Mode

To enable "filter-out" in Advanced Mode, place an event button into either the **Global State** cell or the **Sequence** cell, then right-click the button and choose an **Action** (see previous topic).

From the sub-menu, select **Filter-Out.** See Figure 5.41.

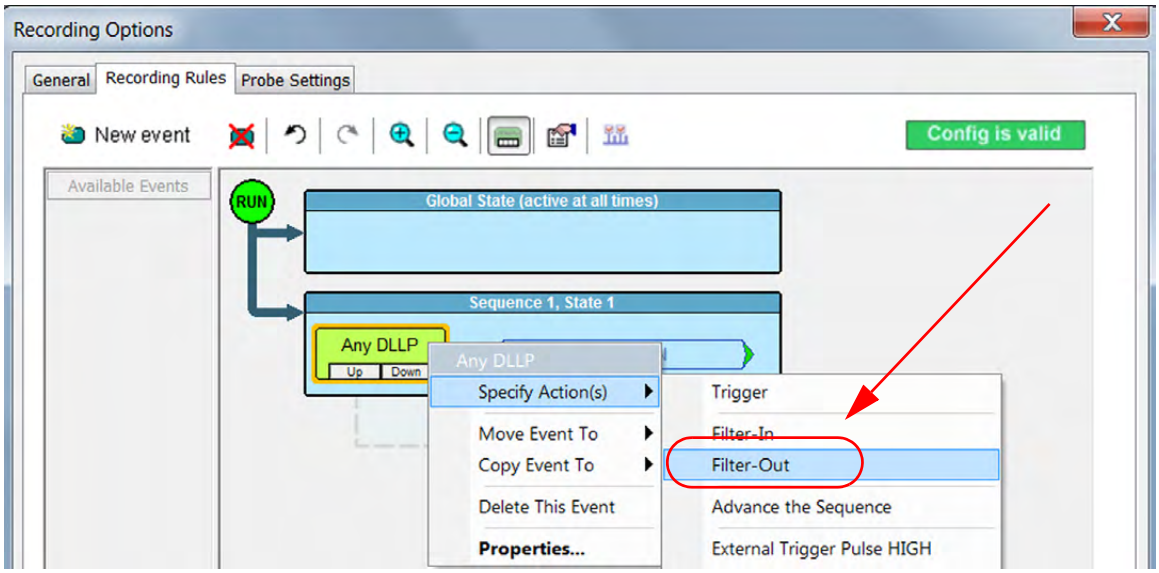


Figure 5.41: Filter Out Option

Note: The Filter-Out option is only available in the DLLP, TLP, TS1 and TS2 Ordered Sets, for Link Events Enter/Exit Electrical Idle, WAKE# Asserted/Deasserted, or CLKREQ# Asserted/Deasserted.

Note: If you did Filter-Out all events (by mistake), you'd create an empty trace and get a warning message (see "Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed." on page 182.)

5.22 Filter In

"Filter in" is the logical opposite of "Filter Out". In this case, you are specifically interested in capturing specific events or traffic and ignoring everything else. If events are filtered in to the recording, they are included in the Analyzer's buffer. The purpose of "filtering in" is to preserve recording memory so you conduct longer recording sessions and include only events that interest you. Filter in is only available in Advanced Mode.

As an example, let's say you want to capture **Any DLLP** and **Any NVMe:ACQ** Commands.

First switch to **Advanced Mode**.

To enable “Filter-In” place an event button (DLLP -> Any DLLP) into the **Global State** cell, then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.**

Then select NVMe under New Event and NVMe Register:ACQ and place that event into the **Sequence 1, State 1** cell. Then right-click the button and choose an **Action**. From the sub-menu select **Filter-In.** See Figure 5.43 on page 95.

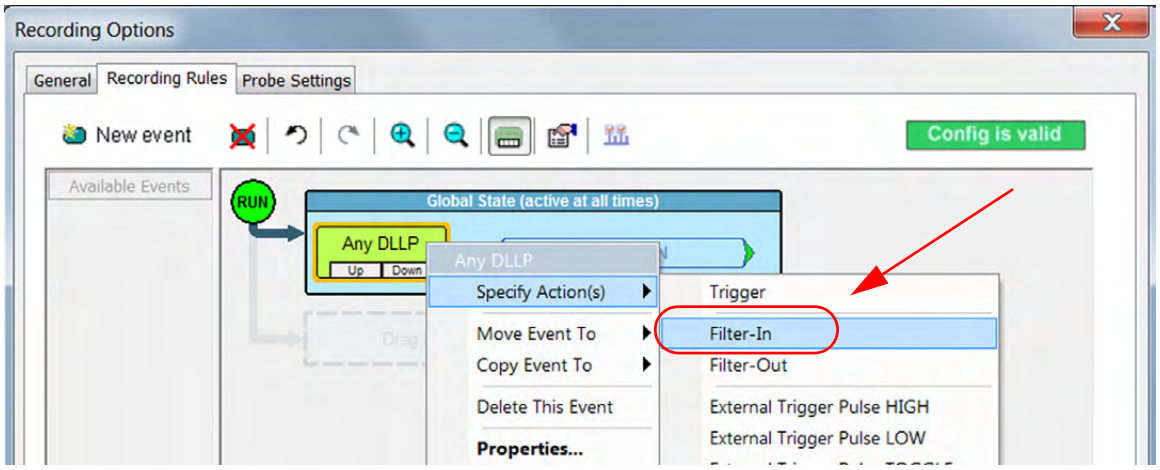


Figure 5.42: Filter In Option

Note: When a **Filter-In** is selected the analyzer filters out everything else by default.

Valid Configuration

In this case, you have chosen a Global State Filter-In on any DLLP and Sequence 1, State 1 to have an NVMe Command:ACQ Filter-In. This is a valid configuration as shown in Figure 5.43.

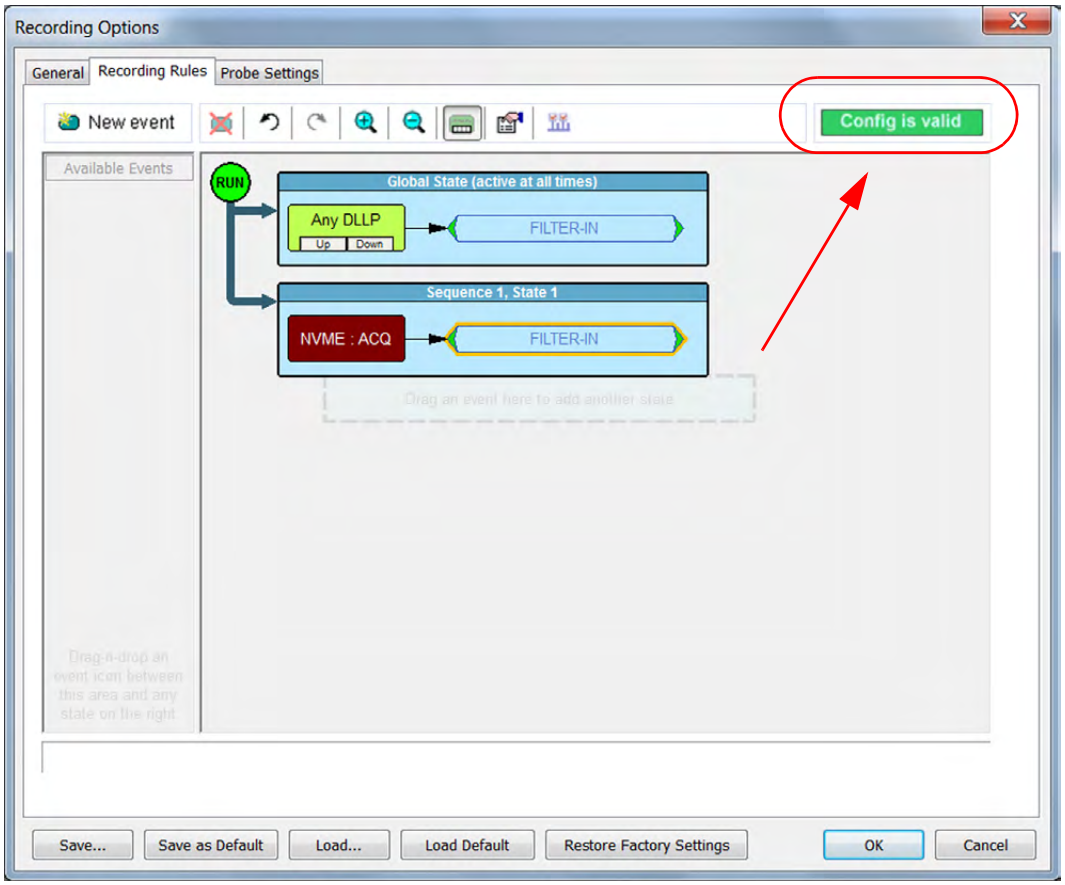


Figure 5.43: Filter In: Advanced Mode: Filter In Any DLLP and Any NVMe ACQ Command

Note: If you change the Global State to Any DLLP but switch to FILTER-OUT you'll get the following warning message: See Figure 5.44 on page 96.

Invalid Configuration

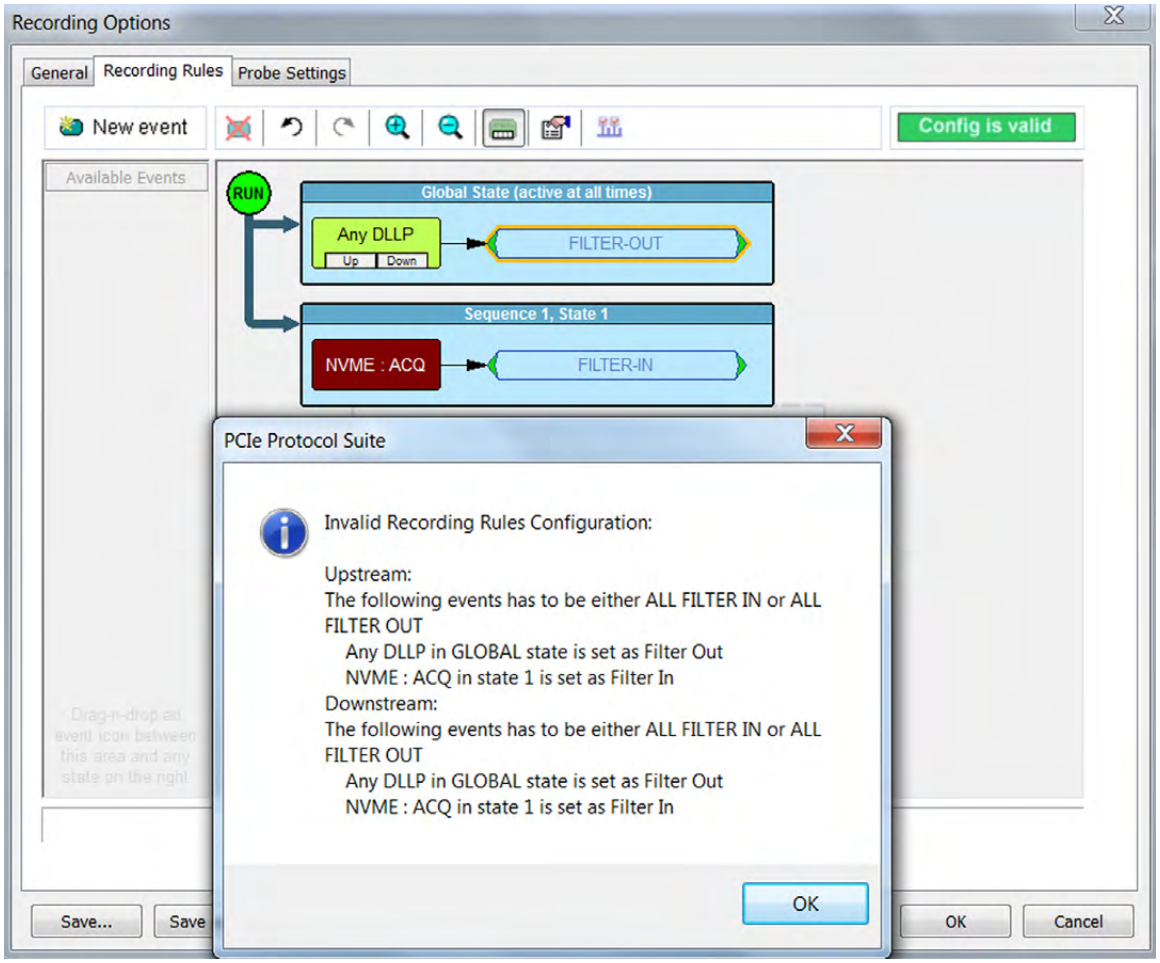


Figure 5.44: Warning Message for Invalid Configuration

The analyzer is warning you that you've set a Global Rule to Filter-Out Any DLLP and that condition will filter out the NVMe:ACQ Command you're looking for. So the recording rules have to be consistent. You'd get the same message if you set Any DLLP to Filter-In but set the NVMe:ACQ Command to Filter-Out. The warning message would pop up and if you hit OK, the **Config is Invalid** message will light up. See Figure 5.45 on page 97.

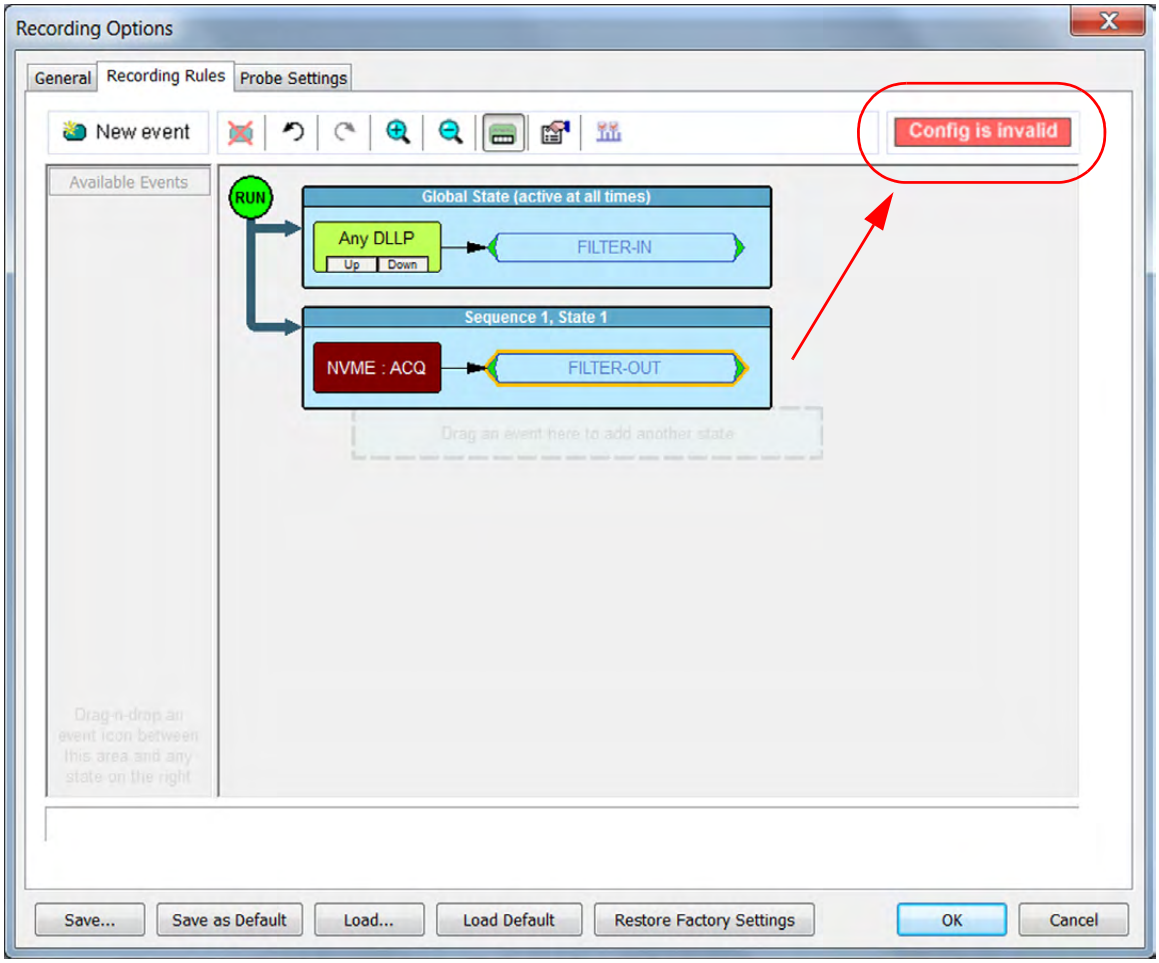


Figure 5.45: Filter In: Any DLLP, Filter Out Any NVMe:ACQ Command -> Invalid Config

So the tool won't let you try to set recording options that are logically inconsistent.

5.23 Triggering Configuration on a per Lane Basis

The Lane Trigger Configuration Icon (available on the Recording Options => Recording Rules toolbar see Figure 5.46) provides the user with the ability to add pre-conditions on specific lanes that the analyzer will use as an additional restriction on a defined triggering event.

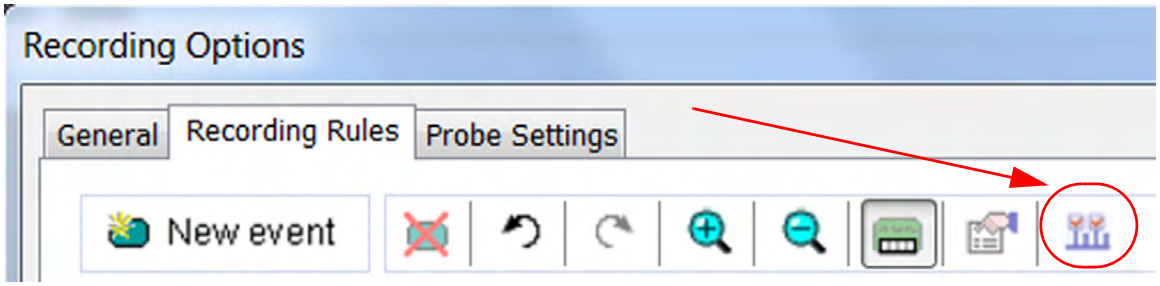


Figure 5.46: Lane Trigger Configuration

This option has three categories of events which can be made lane-based:

- DLLP/TLP Packets
- Errors
- Ordered Sets

Each of these events has restrictions on the lanes available, as spelled out in the GUI.

- This selection will be applied globally
- Lane selection is for logical lanes, not physical lanes
- At least one lane should be selected, the default is all lanes selected
- Picking a non-default lane selection will limit actions to triggering only for that category

DLLP/TLP Packets Category

For DLLP/TLP packets starting in selected lanes, the packet must start in lanes 0, 4, 8 or 12, one or more of these four lanes can be selected to look for the start of DLLP/TLP packets and the selection can be made for each direction.

See Figure 5.47.

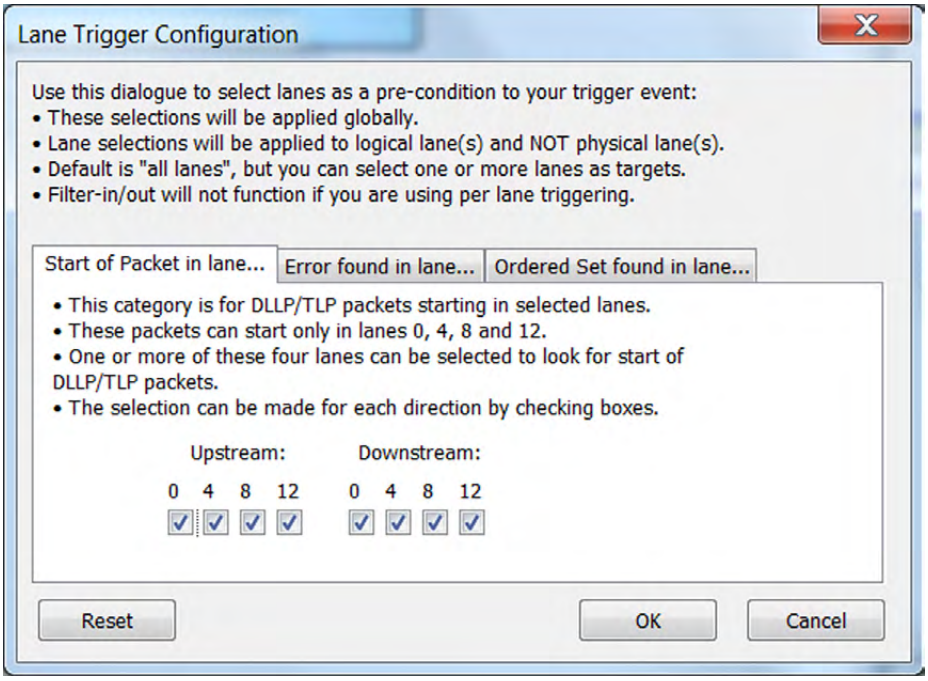

Lane Trigger Configuration
Use this dialogue to select lanes as a pre-condition to your trigger event:
• These selections will be applied globally.
• Lane selections will be applied to logical lane(s) and NOT physical lane(s).
• Default is "all lanes", but you can select one or more lanes as targets.
• Filter-in/out will not function if you are using per lane triggering.
Start of Packet in lane...
Error found in lane...
Ordered Set found in lane...
• This category is for DLLP/TLP packets starting in selected lanes.
• These packets can start only in lanes 0, 4, 8 and 12.
• One or more of these four lanes can be selected to look for start of DLLP/TLP packets.
• The selection can be made for each direction by checking boxes.
Upstream:
0 4 8 12
Downstream:
0 4 8 12
Reset
OK
Cancel

Figure 5.47: Start of Packet in lane GUI

Errors Category

Errors category can be used as a pre-condition to trigger on an event in selected Upstream or Downstream lanes. The types of errors that will be detected are limited to:

- Symbol errors
- Disparity errors
- Block errors

See Figure 5.48.

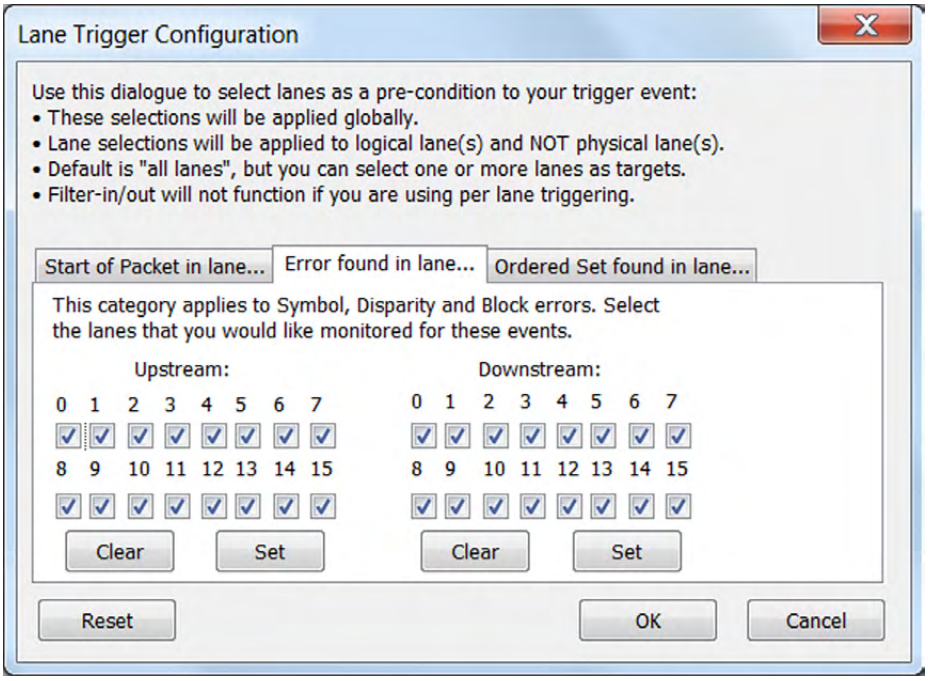

Lane Trigger Configuration
Use this dialogue to select lanes as a pre-condition to your trigger event:
• These selections will be applied globally.
• Lane selections will be applied to logical lane(s) and NOT physical lane(s).
• Default is "all lanes", but you can select one or more lanes as targets.
• Filter-in/out will not function if you are using per lane triggering.
Start of Packet in lane...
Error found in lane...
Ordered Set found in lane...
This category applies to Symbol, Disparity and Block errors. Select the lanes that you would like monitored for these events.
Upstream:
Downstream:
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
Clear
Set
Clear
Set
Reset
OK
Cancel

Figure 5.48: Error Found In Selected Lanes

Ordered Sets Category

This category includes all types of ordered sets (TS1, TS2, EIEOS, EIOS, Skip, FTS, and SDS).

If a specific lane is selected in the Event Properties dialog of a TS ordered set the same specific lane must be selected here or no triggering event will occur.

See Figure 5.49 on page 101.

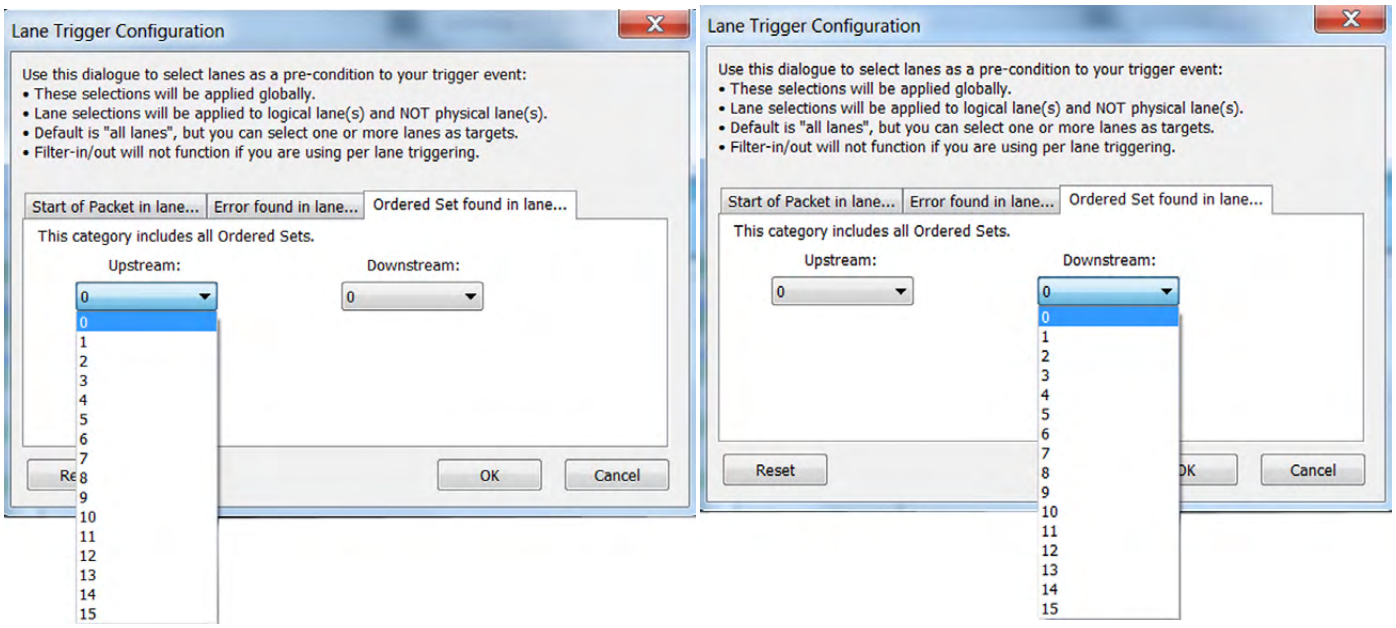


Figure 5.49: Ordered Sets Found in Upstream and Downstream Lanes

Lane Trigger Configuration Example 1:

If you need to trigger on TLPs that start on lane 4 in the upstream direction perform the following selection (see Figure 5.50):

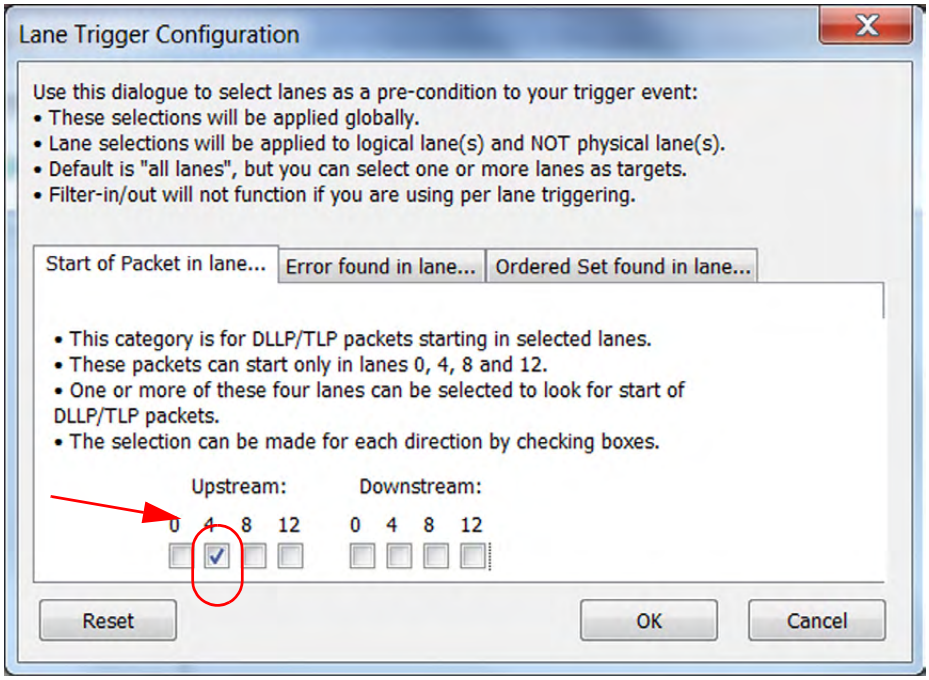

Lane Trigger Configuration
Use this dialogue to select lanes as a pre-condition to your trigger event:
• These selections will be applied globally.
• Lane selections will be applied to logical lane(s) and NOT physical lane(s).
• Default is "all lanes", but you can select one or more lanes as targets.
• Filter-in/out will not function if you are using per lane triggering.
Start of Packet in lane...
Error found in lane...
Ordered Set found in lane...
• This category is for DLLP/TLP packets starting in selected lanes.
• These packets can start only in lanes 0, 4, 8 and 12.
• One or more of these four lanes can be selected to look for start of DLLP/TLP packets.
• The selection can be made for each direction by checking boxes.
Upstream:
0 4 8 12
Downstream:
0 4 8 12
Reset
OK
Cancel

Figure 5.50: Lane Trigger Configuration: Example 1

Then select the appropriate event to trigger the analyzer.

Lane Trigger Configuration Example 2:

If you need to trigger the analyzer on errors happening on lanes 4 and 6 in the upstream direction, perform the following selections:

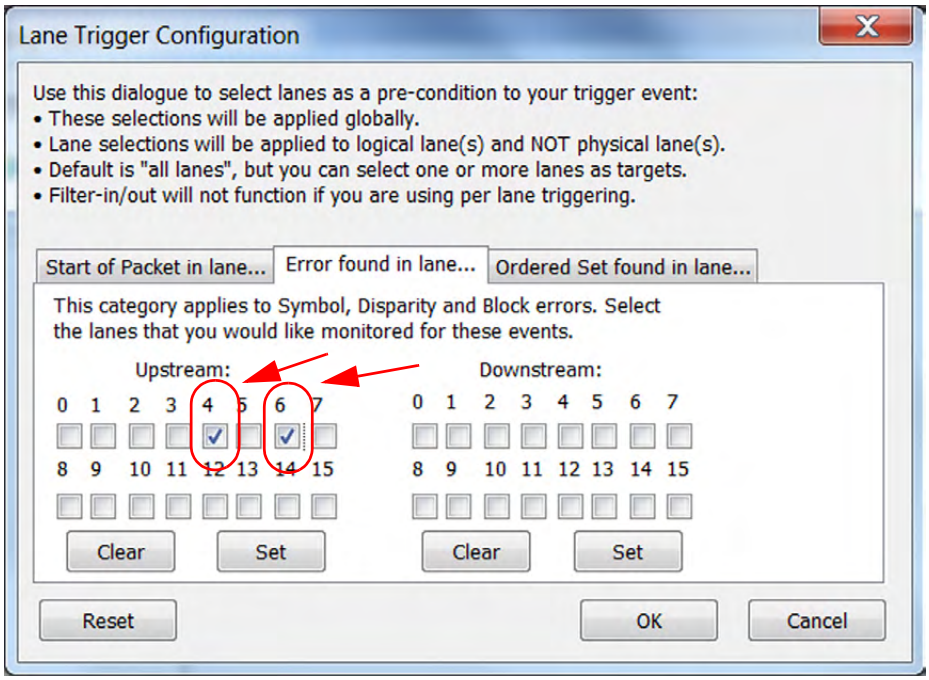

Lane Trigger Configuration
Use this dialogue to select lanes as a pre-condition to your trigger event:
• These selections will be applied globally.
• Lane selections will be applied to logical lane(s) and NOT physical lane(s).
• Default is "all lanes", but you can select one or more lanes as targets.
• Filter-in/out will not function if you are using per lane triggering.
Start of Packet in lane...
Error found in lane...
Ordered Set found in lane...
This category applies to Symbol, Disparity and Block errors. Select the lanes that you would like monitored for these events.
Upstream:
Downstream:
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
Clear
Set
Clear
Set
Reset
OK
Cancel

Figure 5.51: Lane Trigger Configuration: Upstream Errors on Lanes 4 and 6

Then select the appropriate event to trigger the analyzer.

Lane Trigger Configuration Example 3:

If you need to trigger on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction, perform the following selections for Lane Triggering (see Figure 5.52 on page 104):

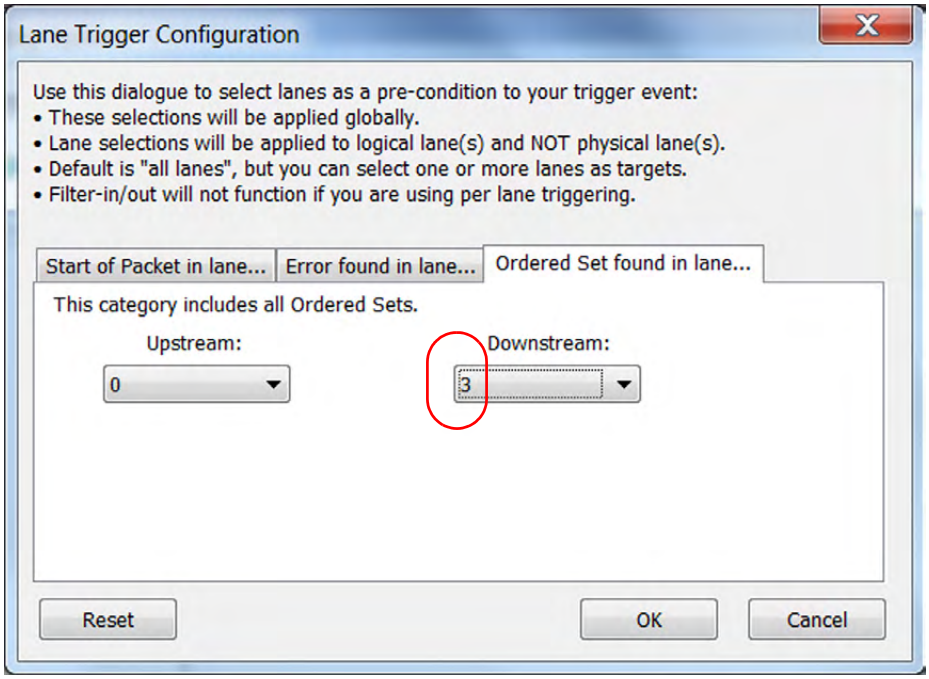

Lane Trigger Configuration
Use this dialogue to select lanes as a pre-condition to your trigger event:
• These selections will be applied globally.
• Lane selections will be applied to logical lane(s) and NOT physical lane(s).
• Default is "all lanes", but you can select one or more lanes as targets.
• Filter-in/out will not function if you are using per lane triggering.
Start of Packet in lane...
Error found in lane...
Ordered Set found in lane...
This category includes all Ordered Sets.
Upstream:
Downstream:
0
3
Reset
OK
Cancel

Figure 5.52: Lane Trigger Configuration: Downstream TS1, Downstream, Lane 3

Then select a TS1 Event and select only the Downstream direction, set Link Number = 00 and Lane number = PAD fields (see Figure 5.53):

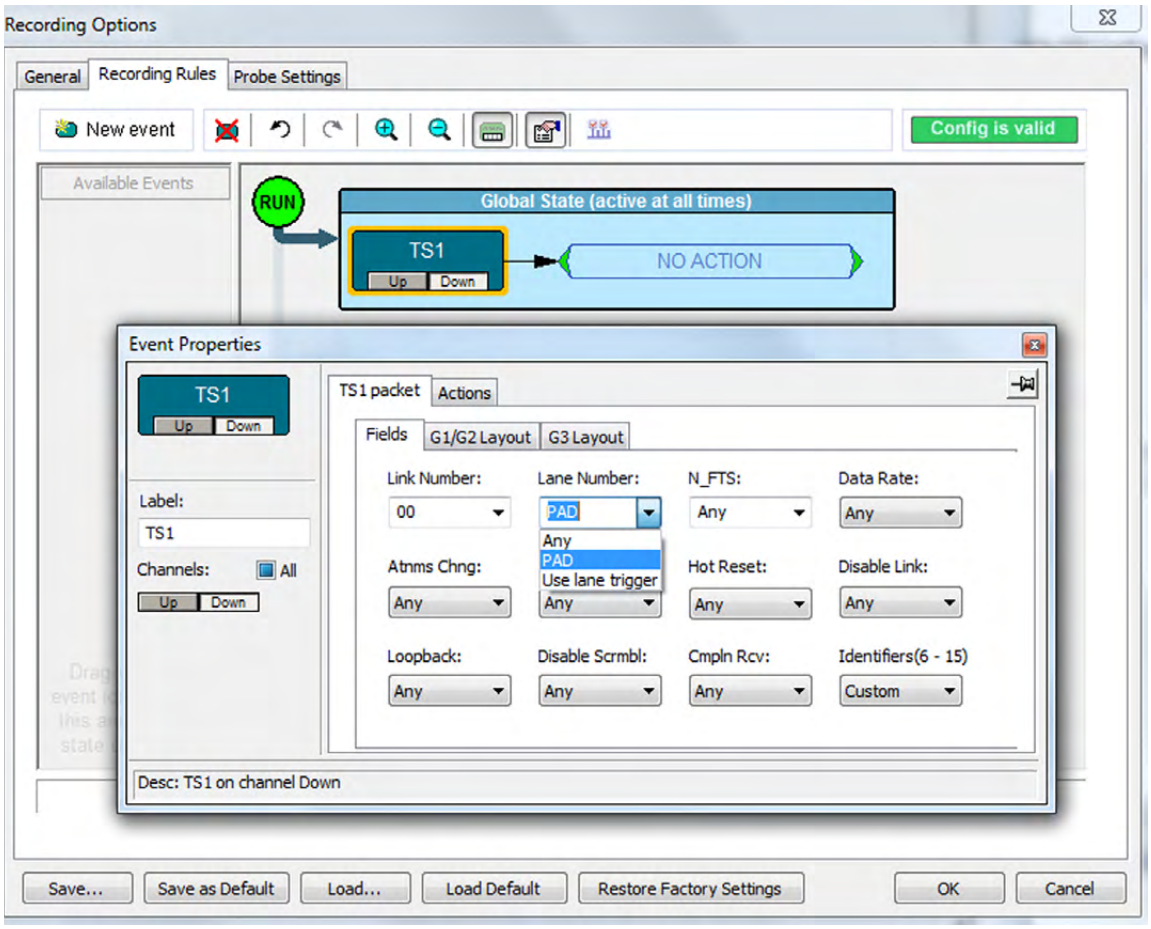


Figure 5.53: Setting the Event Properties for TS1 Downstream

Finally, set the Action Tab to trigger the analyzer (see Figure 5.54 on page 106).

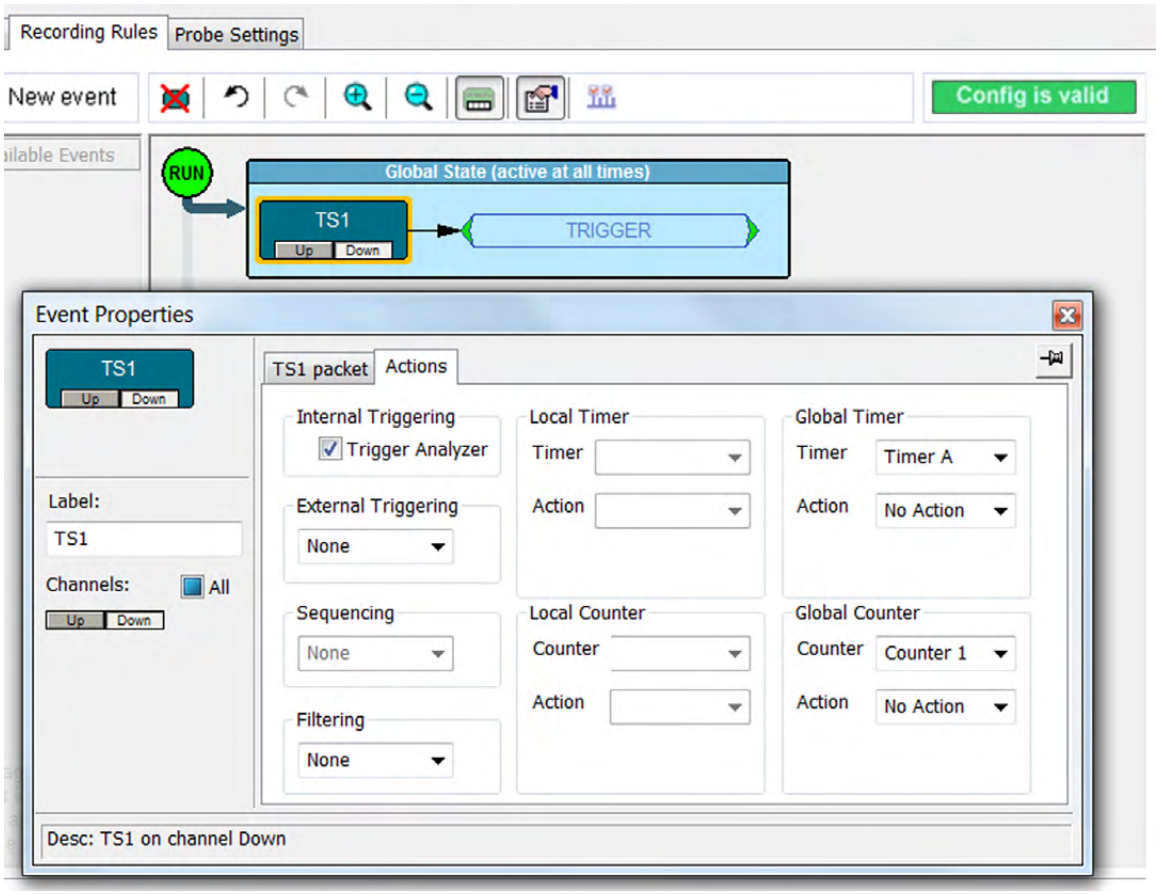


Figure 5.54: Event Properties: Actions = Trigger Analyzer

Now the analyzer will be triggered on a TS1 Event with Link Number = 00 and Lane Number = PAD that happens on Lane 3 only in the Downstream direction.

5.24 Counter

Counters can be created for any specific event or for multiple events. Counters function similar to an event and are independent of the event, thus allowing greater flexibility. You can select a counter for any event and if both channels are selected you can set the counter to count upstream and downstream. Counters can be reset providing further flexibility. The counter once set lives in the State. In an Advance to Sequence state once the action proceeds from one sequence state to the next, the counter in the preceding state will stop and the counter in the current state will start.

There are two Counters for the Global State and four Counters for the Sequence State.

Note: It is an invalid configuration for some events when you try and set a counter and timer when both channels are selected.

The counters have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states (see Figure 5.55 on page 107).

Note: Global timers/counters can be used by events from any direction as long as the events occur more than 380 ns apart. State timer/counters can be controlled only from one direction not both, meaning starting, reset and incrementing must be done from events occurring in the same direction of the selected timer/counter.

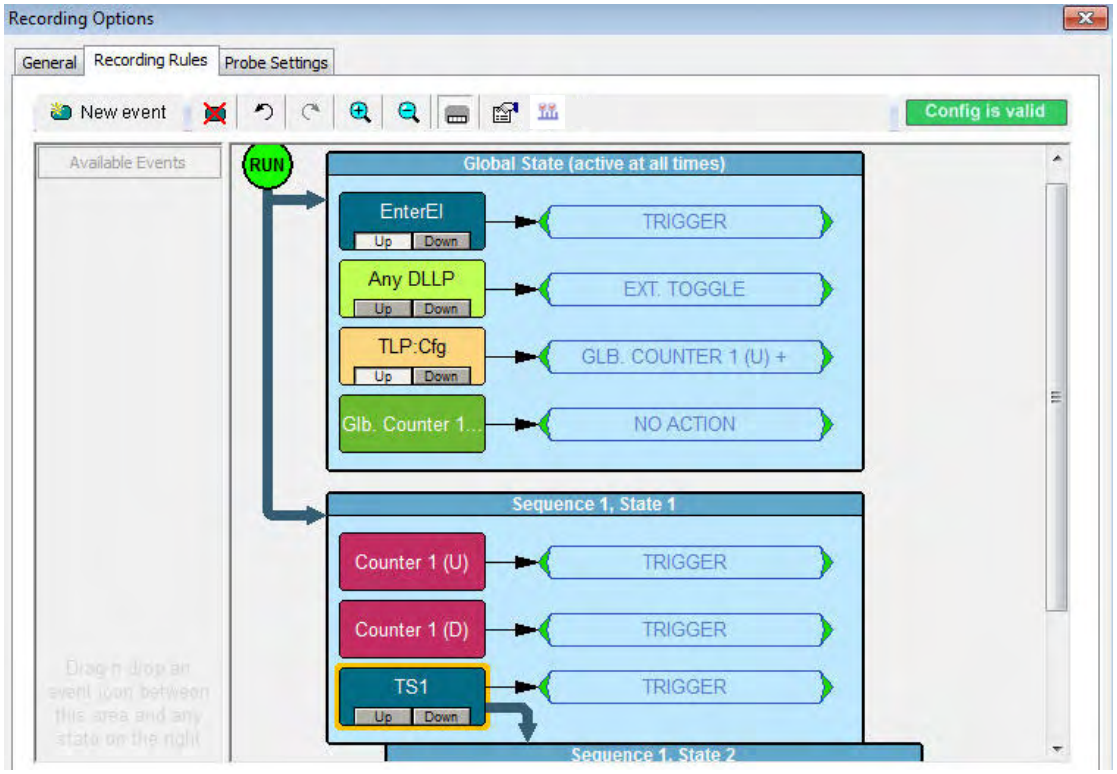


Figure 5.55: Global and Sequence State Counters.

As shown in Figure 5.55 there is a Global Counter 1, set to the value of 2 on channel up displayed in green in the Global State and there are two counter 1s, set to the value of 2, one counting upstream and the other counting downstream displayed in pink in the Sequence State.

5.24.1 How to Set a Counter

Counters are events and you can add a counter to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Counter > UpStream or DownStream**.

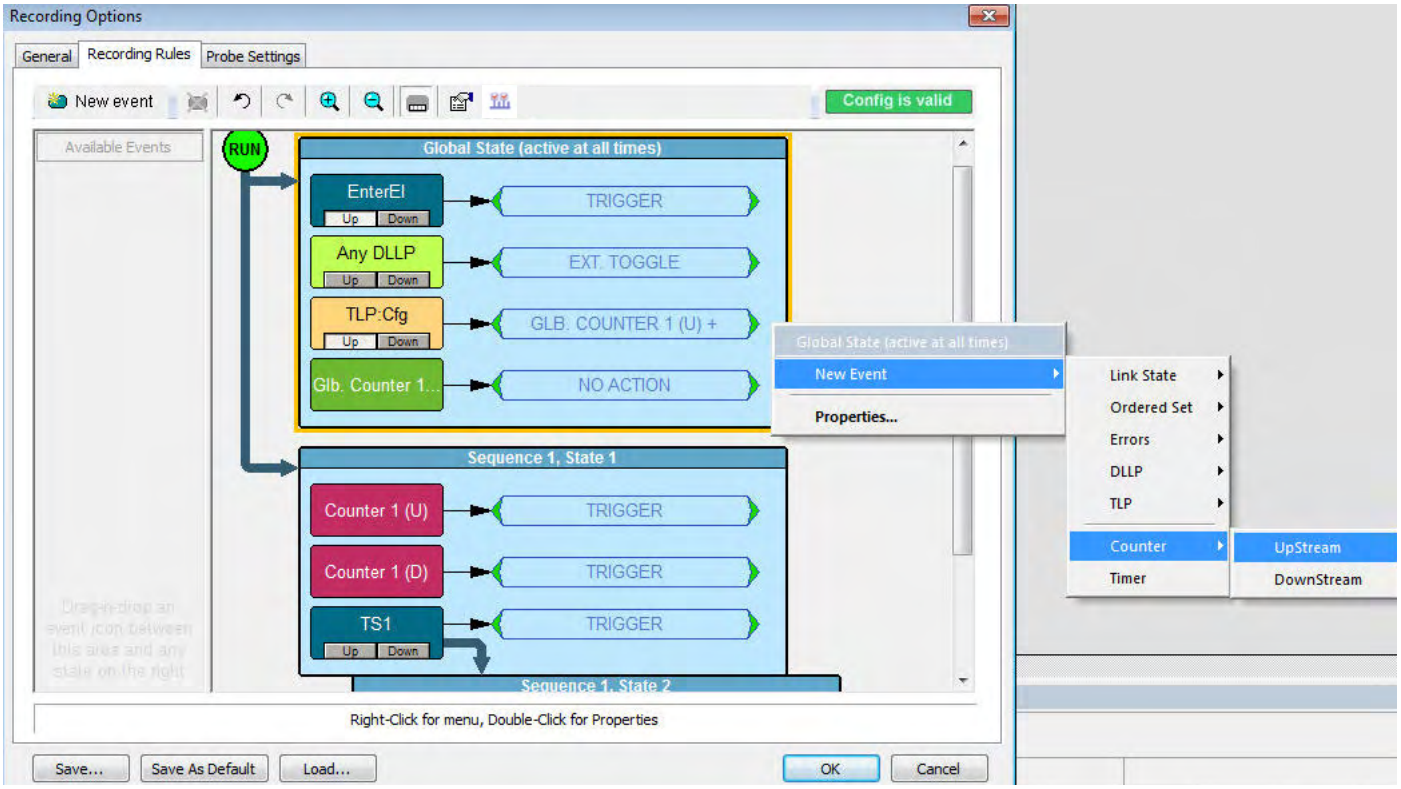


Figure 5.56: Setting Global and Sequence State Counter Events.

5.24.2 How to Increment or Reset a Counter

You can Increment or Reset counters in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see “Probe Settings” on page 115).
2. Right-click on an event and select **Specify Actions > Increment Global Counter > Global Counter 1** from the menu (see Figure 5.57 on page 109).

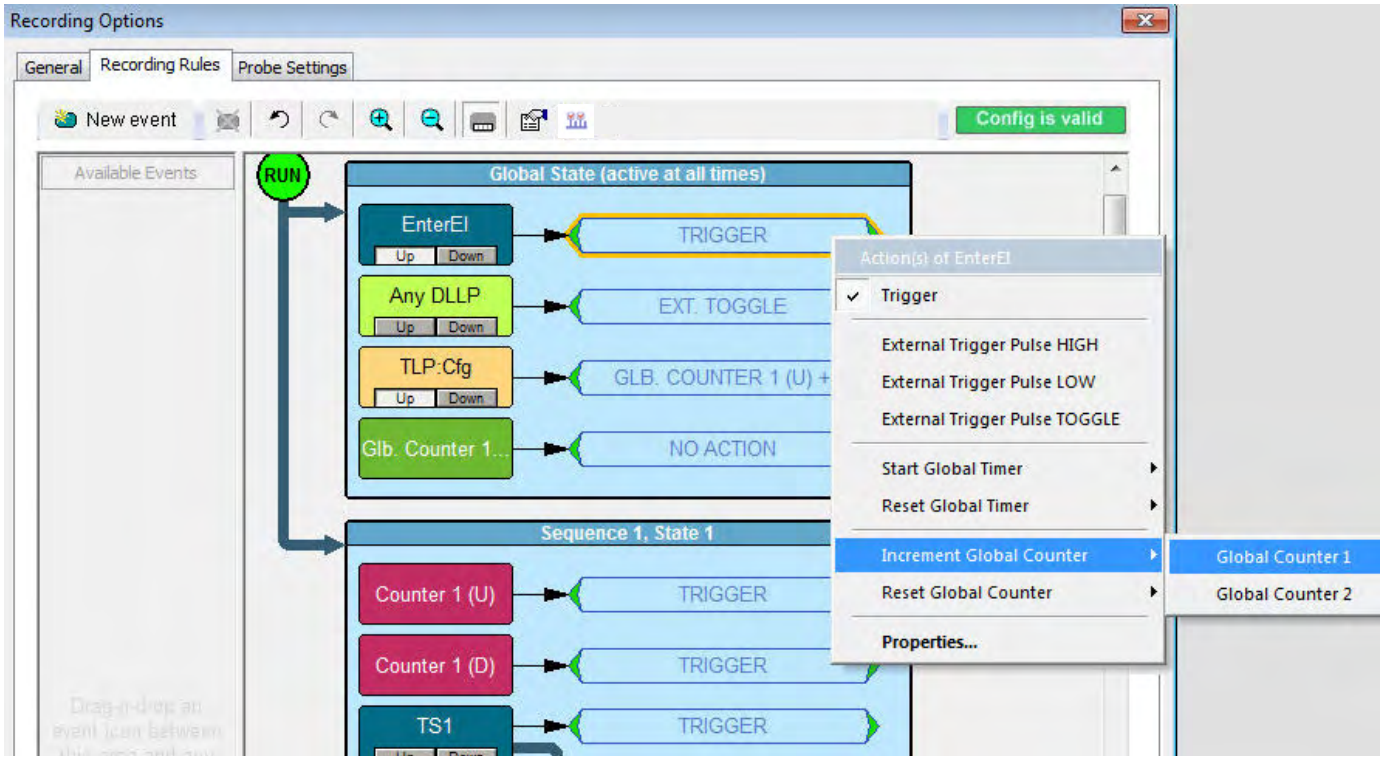


Figure 5.57: Incrementing and Resetting Global and Sequence State Counters

Note: Listed below are some of the considerations to note about the counter functionality

1. If a counter is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a counter will stop it and set it to it's original value.
3. Local counters for a particular state will automatically reset if the sequencer advances to another state. Example: "Counter A" in State 1 and "Counter A" in State 2 are different timers not related to each other.
4. Local counters are controlled by events defined in the same state where the counters are defined.
5. In case of competing actions to control global counters using the same event from global and local states, the control from local states takes priority.

5.24.3 Changing the Value of the Counter

To change the value of the counter:

1. Double-click on the Counter.
2. Enter a new value in the pop-up dialog. This causes the new value to appear in the counter button.

5.24.4 Deleting a Counter

To delete a counter

1. Right-click on the Counter.
2. Select **Delete This Event.** The counter will disappear from the event.

5.25 Timer

The Timer has two options which are Start and Reset (see Figure 5.58 on page 111). When set to Start it starts the timer and when set to Reset it resets the timer to its initial value. When the timer count is down to 0 the action is triggered.

The Global State timer can trigger, start an action. It can also affect some other timers and counters.

Note: It is an invalid configuration for some events when you try and set a counter and timer when both channels are selected.

The timers have different colors for the Global State and Sequence State. Each color signifies a different meaning in the Global and Sequence states.

There are two Timers for the Global State and four Timers for the Sequence State.

Note: Global timers/counters can be used by events from any direction as long as the events occur more than 380 ns apart. State timer/counters can be controlled only from one direction not both, meaning starting, reset and incrementing must be done from events occurring in the same direction of the selected timer/counter.

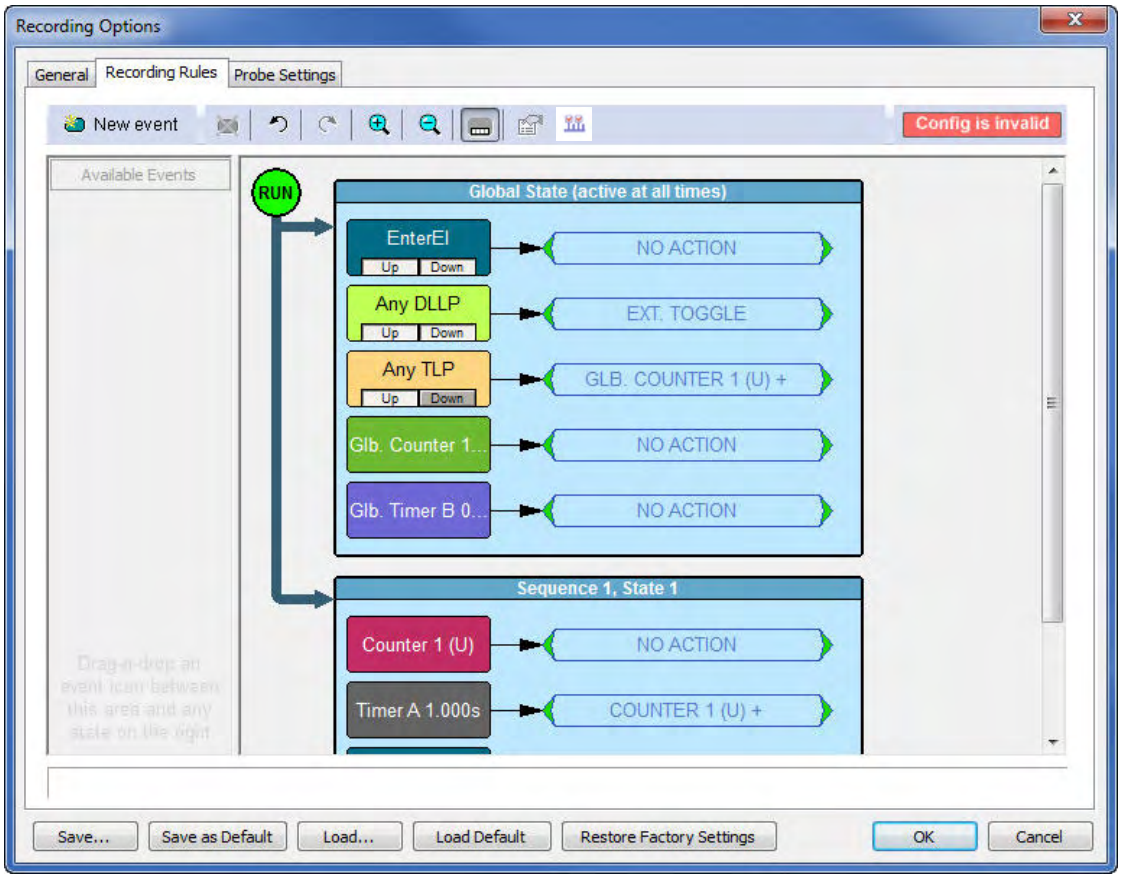


Figure 5.58: Global and Sequence State Timers

As shown in Figure 5.58 there is a Global Timer A, set to the value of 1.000s on channel Up displayed in blue in the Global State and there is one timer A, set to the value of 1.000s on channel Down displayed in brown in the Sequence State.

5.25.1 How to Set a Timer

Timers are events and you can add a timer to the Global State or the Sequence State as an event by doing the following:

Right-click in the blue space in the Global or Sequence State and **New Event > Timer**.

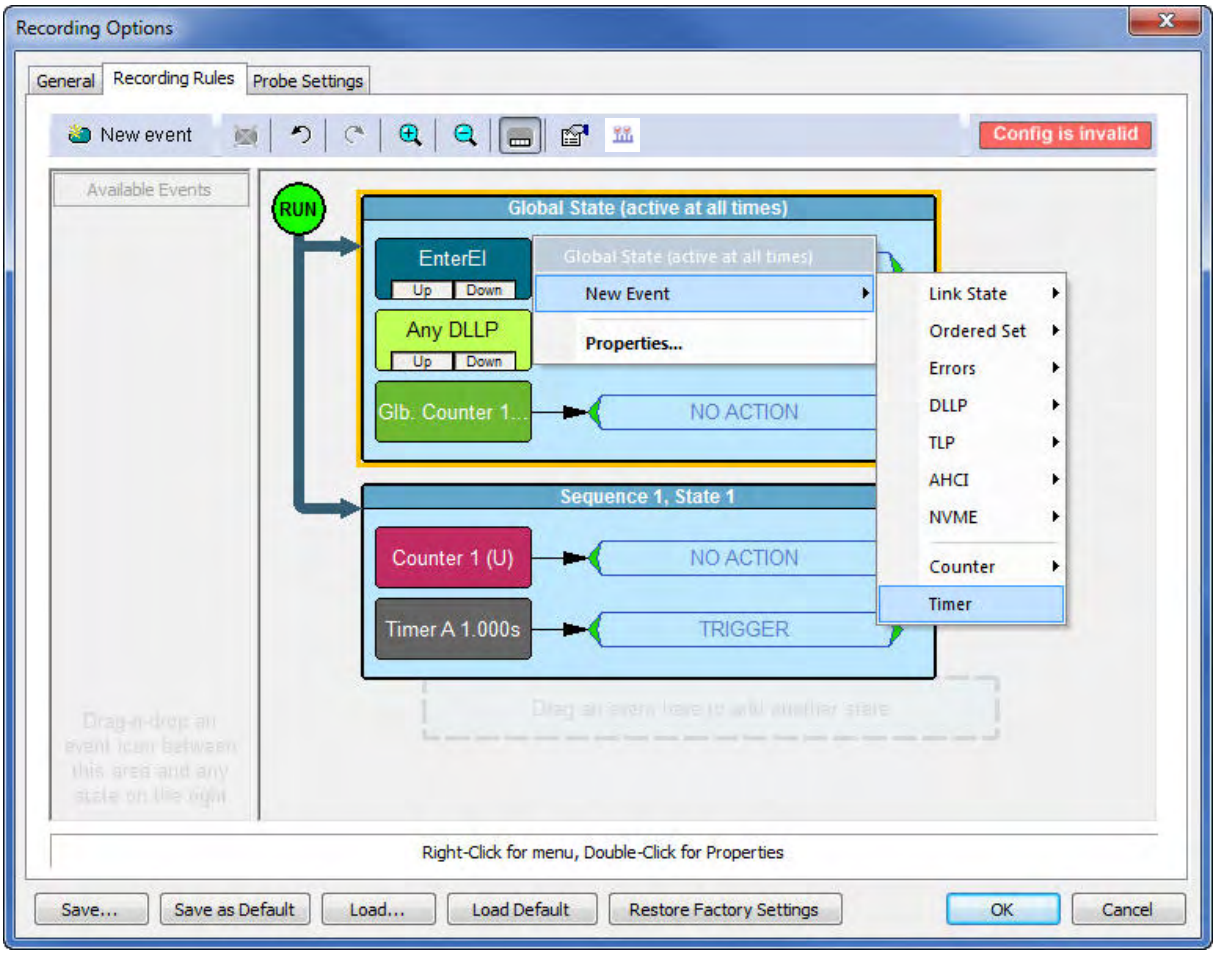


Figure 5.59: Setting Global and Sequence State Timer Events

5.25.2 How to Start or Reset a Timer

You can Start or Reset the Timer in the Global State and in the Sequence State by performing the following steps:

1. Open the Recording Rules page, select an event, and drag it to the **Global State** or **Sequence** cells. For details on these steps (see “Probe Settings” on page 115).
2. Right-click on an event and select **Specify Actions > Start Global Timer > Global Timer A** or **Timer B** from the menu (see Figure 5.60 on page 113).

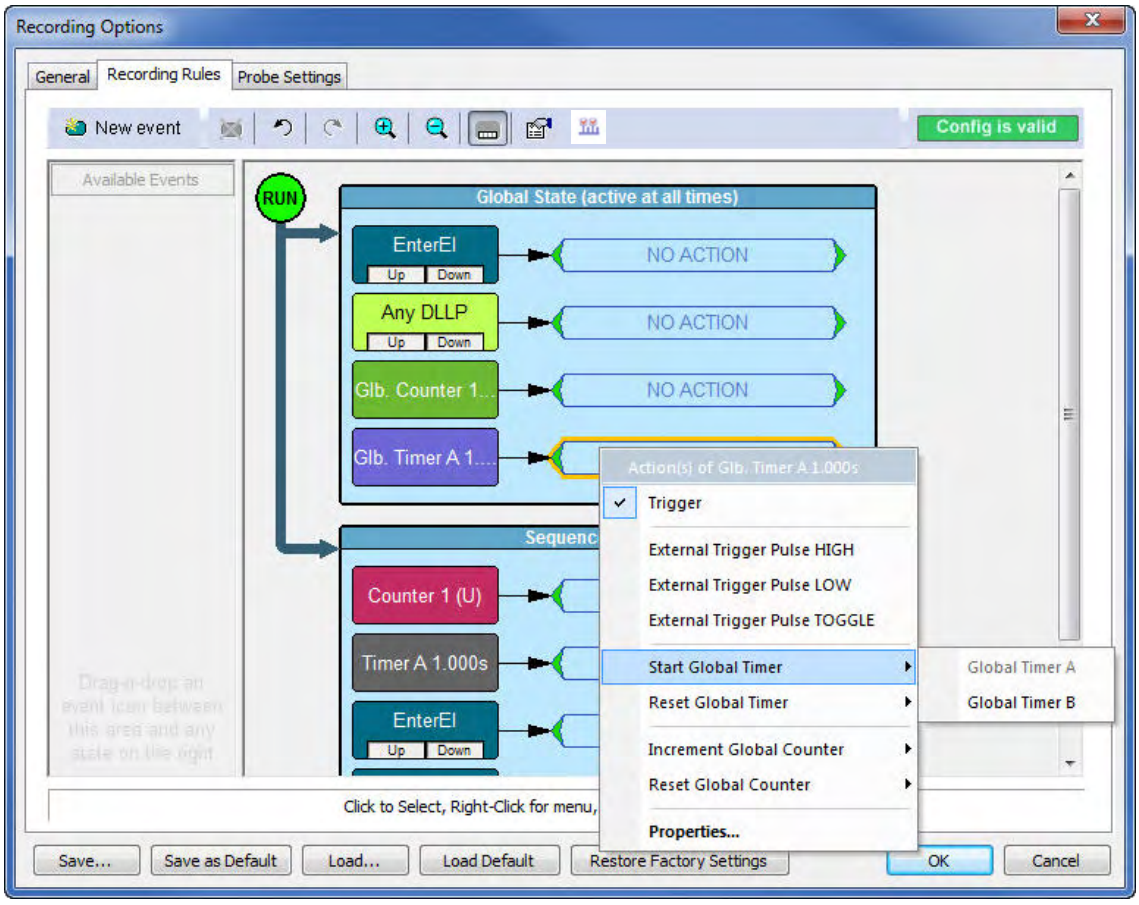


Figure 5.60: Starting and Resetting Global and Sequence State Timers

Note: Listed below are some of the considerations to note about timer functionality

1. If a timer is reset, it will restore to it's original value, in this case the value defined by the user.
2. Resetting a timer will stop it and set it to it's original value.
3. Local timers for a particular state will automatically reset if the sequencer advances to another state. Example: "Timer A" in State 1 and "Timer A" in State 2 are different timers not related to each other.
4. Local timers are controlled by events defined in the same state where the timers are defined.
5. In case of competing actions to control global timers using the same event from global and local states, the control from local states takes priority.

5.25.3 Changing the Value of the Timer

To change the value of the timer:

1. Right-click on the Timer.
2. Select **Properties** (see Figure 5.61 on page 114).

3. Enter in values for the Timer in the fields provides in Secs, Millisecs, Microsecs and Nanosecs on the Timer tab.

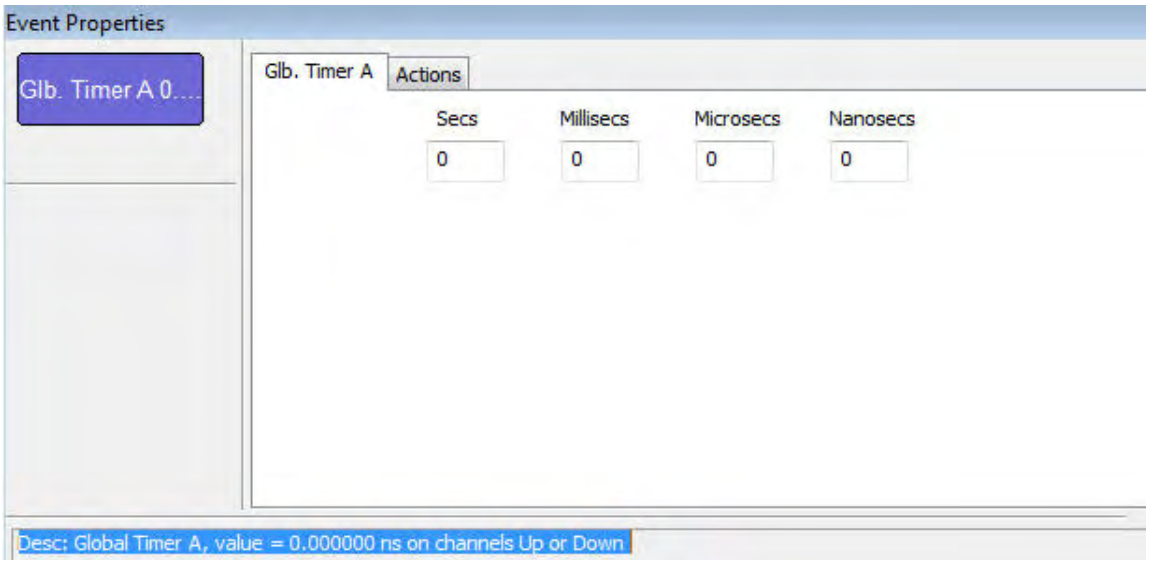


Figure 5.61: Setting the Timer Values

4. Click on the Actions tab and set the External and Internal Triggering, Sequencing and Filtering options. You can label the timer.

5.25.4 Deleting a Timer

To delete a Timer

1. Right-click on the Timer.
2. Select **Delete This Event.** The Timer will disappear from the event.

5.26 Channel

Every event has two channels, one upstream and the other downstream. You can use both channels with any event. The channels are independent of each other. If both channels are selected it is valid but no action occurs, and thus no timer and counter is created. Figure 5.62 shows three events in the Global State, the first event is on Channel Up and the 3rd event is on Channel Down.

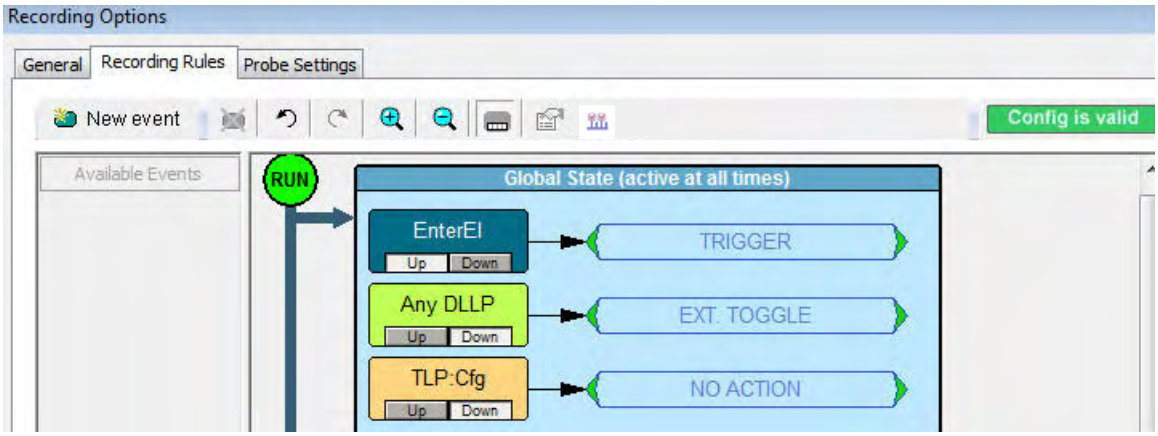


Figure 5.62: Events with Channels

5.27 Probe Settings

The Summit T24 analyzer can be optimized for specific DUT signal characteristics. The auto calibration feature in the Probe Settings allows for better signal recovery. There are 16, 0 db to 15 db, internal equalization modes in the analyzer hardware that boost the high frequency content of the captured signal. This equalization does not impact the signal to the DUTs, but helps in 'opening the eye' of the captured signal, so that the internal logic can capture PCIe frames. The system is designed to allow you to manually set the equalization to one of the sixteen modes for the CTLE values and one of the eight modes for the DFE values or choose to run an automated algorithm, internal to the analyzer. This automated calibration sets the optimized values for each of the PCIe captured lanes, provided that the signal at the analyzer input is stable.

Two lane settings can be configured, CTLE and DFE (Decision Feedback Equalization). CTLE is two dimensional and is set based on the least number of errors returned. DFE is three dimensional and is set based on the least number of errors returned by both CTLE and DFE.

Select **Recording Options > Probe Settings** from the **Setup** menu to display Probe Settings**.**

Setting Auto Calibration

The Probe Settings tab in the Recording Options dialog displays the equalizer settings. To set all lanes upstream and downstream check the **Set All Lanes** box**.** Click on **Auto Calibration** to display the **Calibrate** dialog (see Figure 5.64 on page 117).

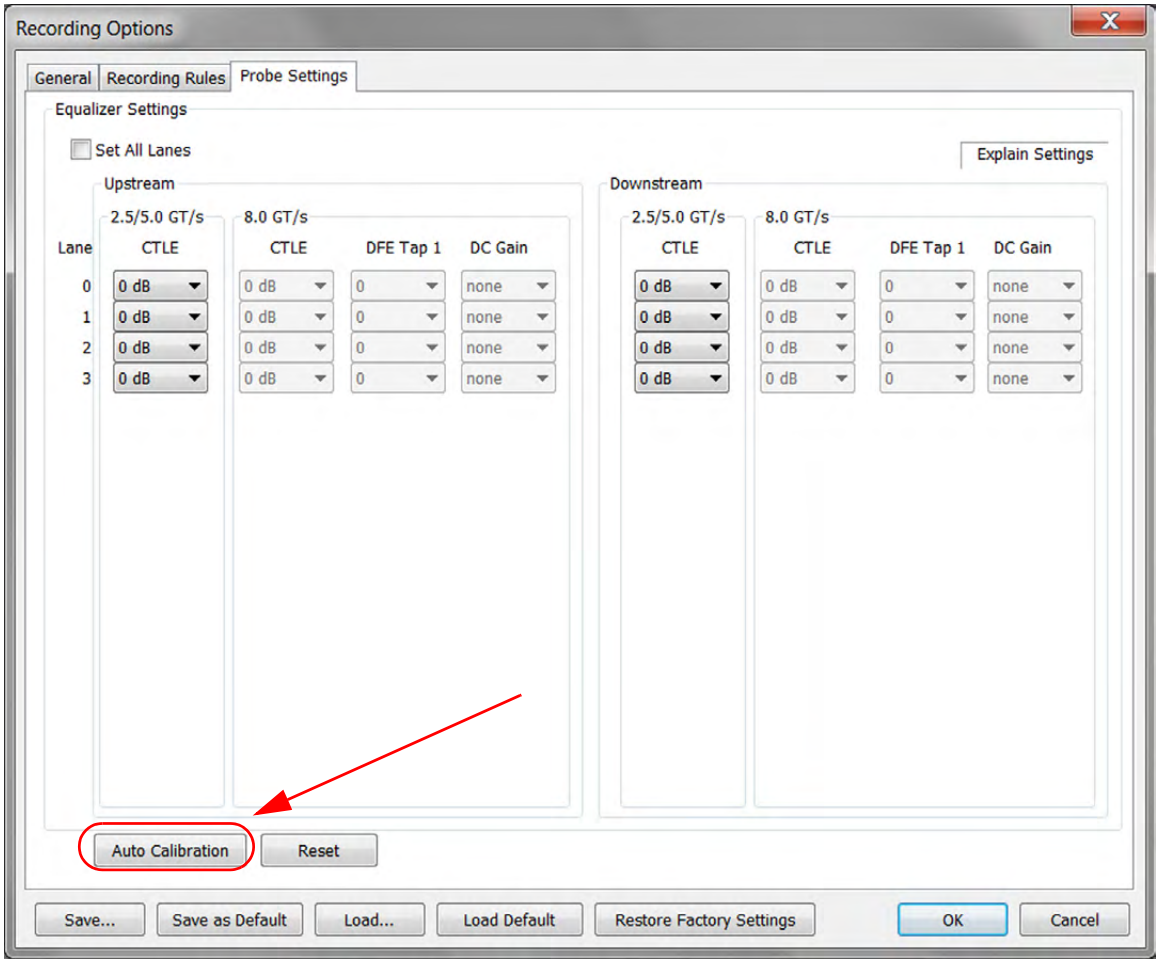


Figure 5.63: Probe Settings Tab

You can auto calibrate the probe settings by clicking on the Auto Calibration button. In order to calibrate the device the link should be trained to the widest width and the highest speed. Specify the link width, speed and lane polarity click **Start Calibration** (see Figure 5.64 on page 117)**.** By default, the polarity settings are carried over from the recording options menu.

To use the external reference clock or for quick calibration click the appropriate checkboxes to select them. If checked, calibration routine will only scan CTLE, if not checked it will include DFE with the CTLE scan which will take longer, approximately 9 minutes.

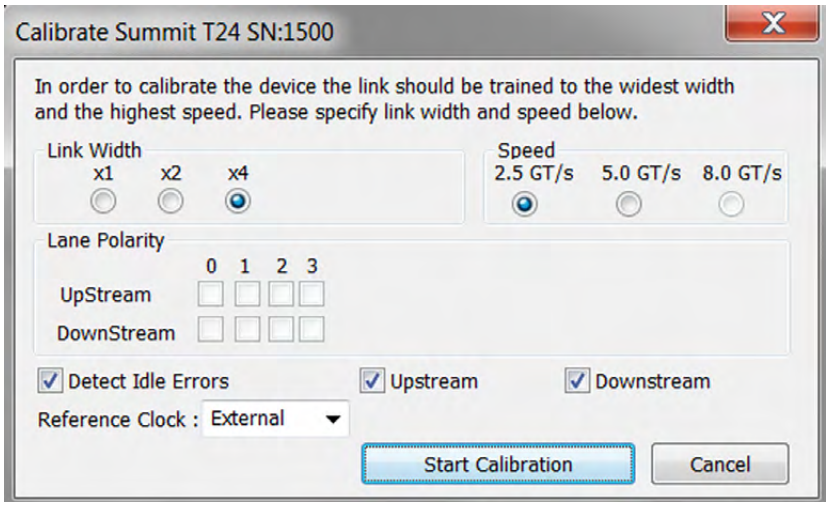


Figure 5.64: Auto Calibrate Dialog

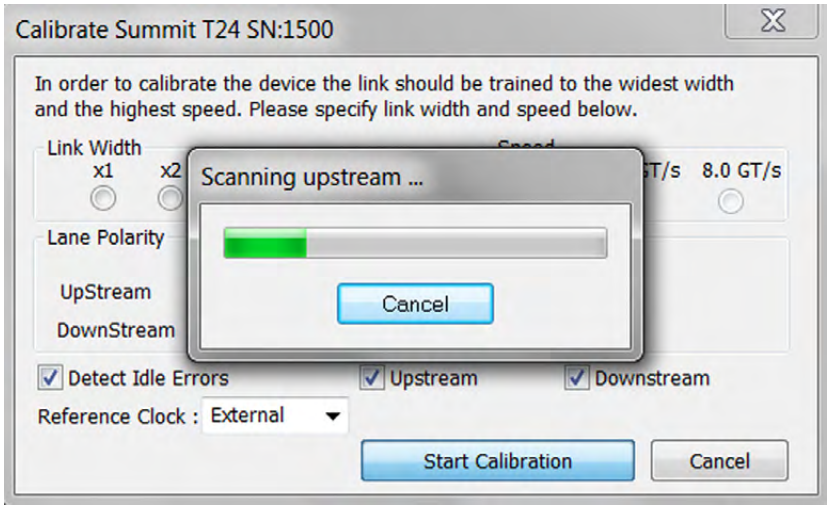


Figure 5.65: Auto Calibration Running

The calculated CTLE values are automatically displayed in the relevant lane field. Click **Save** to save the settings or click **Save As Default** to save the settings as the default. Click **Load** to save the settings as a .rec file as a PE Tracer Recording option to be used at a later time. Click **Reset** to clear the settings (see Figure 5.66 on page 118).

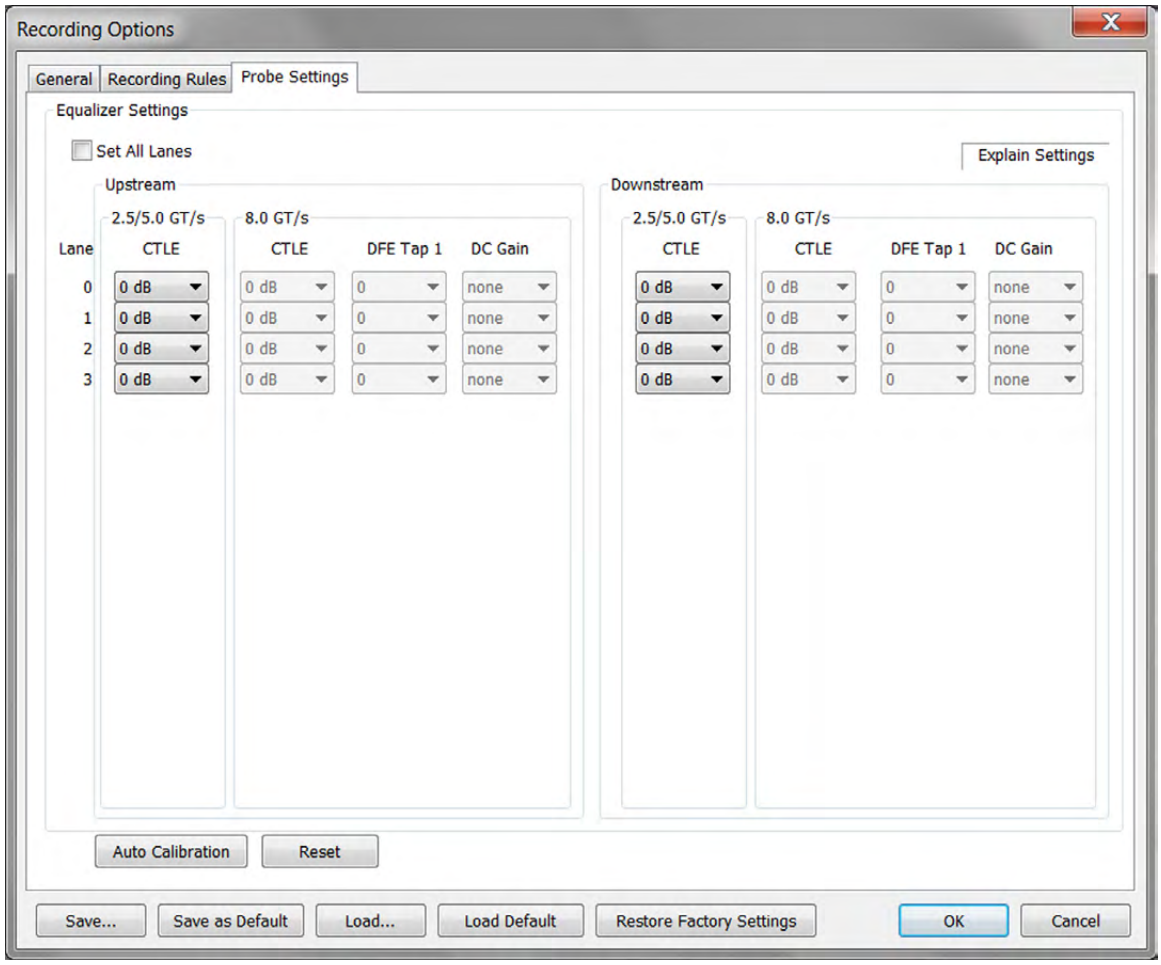


Figure 5.66: Auto Calibration Settings

5.27.1 Save

The Save function in the Recording Rules and the Probe settings tab has the following options:

- Save the whole Recording Options (.rec)
- Save only the Recording Rules portions of the recording options (.rr)
- Save only the Probe Settings portions of the recording options (.ps)

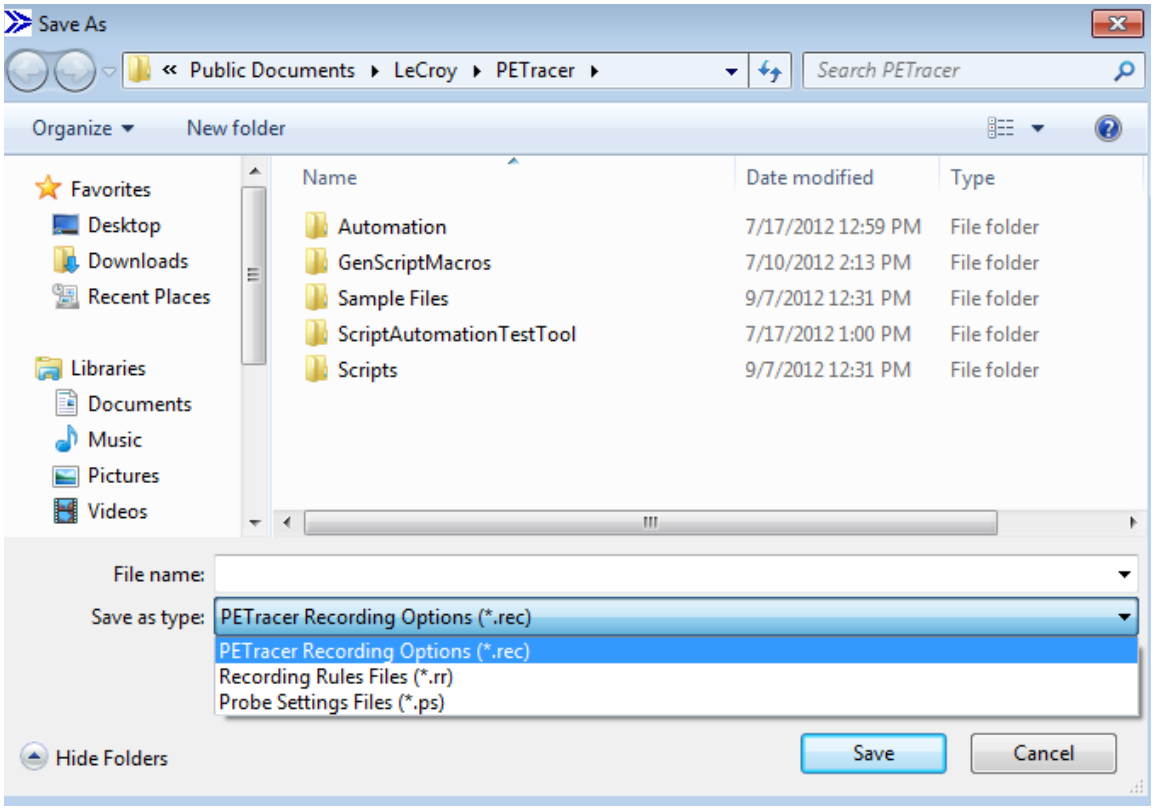


Figure 5.67: Save As Dialog

5.27.2 Load

The Load function in the Recording Rules and the Probe settings tab has the following options:

- Load the whole Recording Options (.rec)
- Load the Recording Options of a PCIe Trace File (.pex)
- Load only the Recording Rules portions of the recording options (.rr)
- Load only the Probe Settings portions of the recording options (.ps)

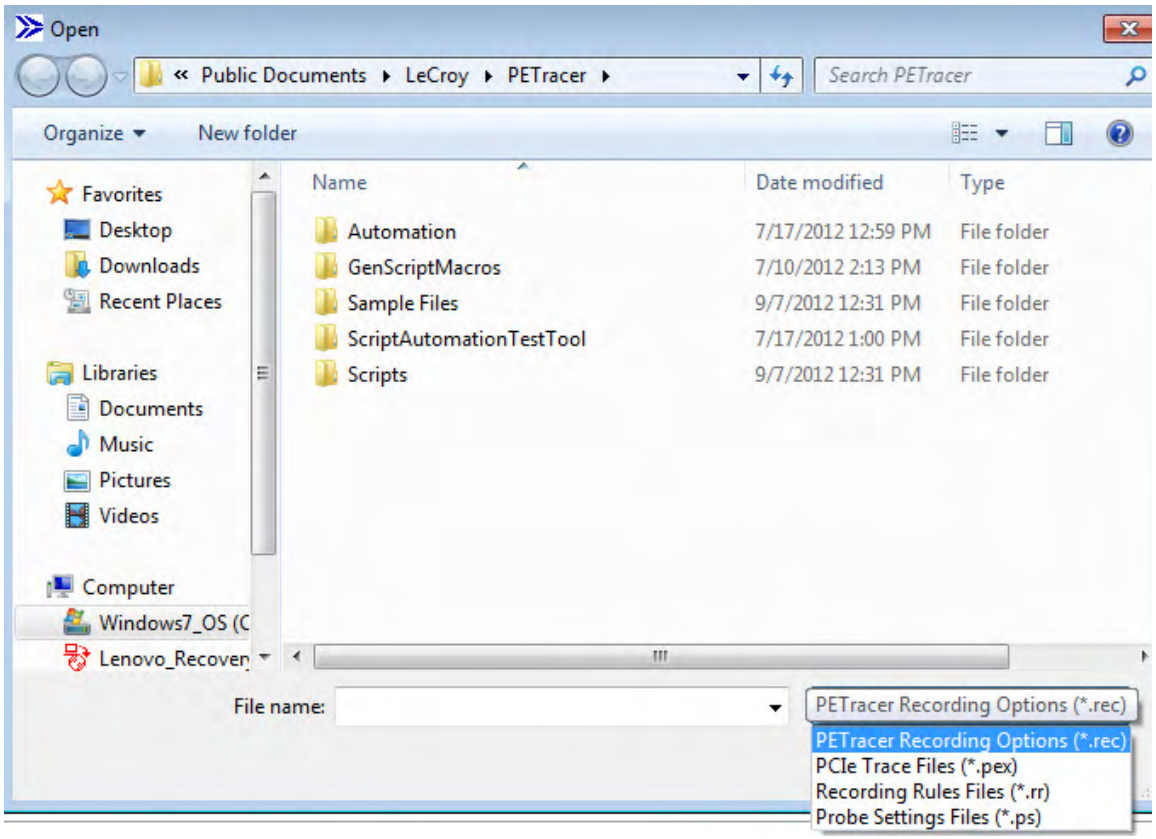


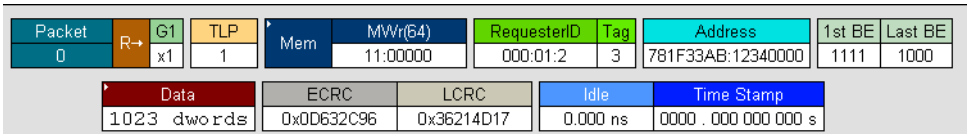
Figure 5.68: Load Dialog

Chapter 6

Reading CATC Traces

6.1 Viewing PCI Express CATC Traces

PCIe Protocol Suite™ displays traffic as labeled, color-coded, and time-stamped rows.



Tool tips provide details about fields within the CATC Trace. Hold the mouse cursor over a field to see a tool tip.

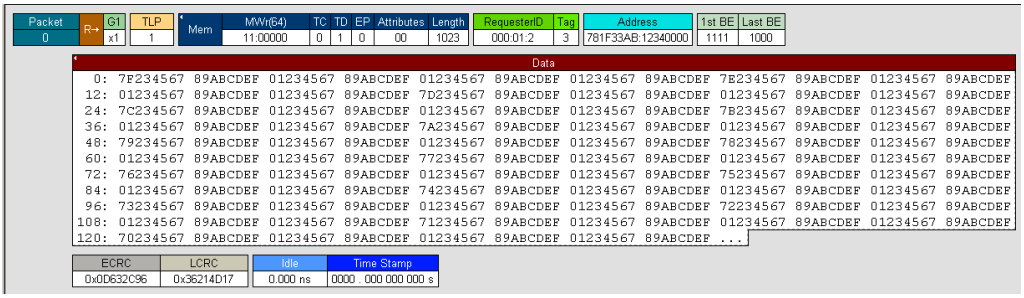
Additional information is available from pop-up menus. For example, if you click the left mouse button on the first cell in a packet a menu appears with an option to view Raw 10b Codes.

6.2 Expand and Collapse Data Fields

Packet data fields are displayed in a short format by default.

You can view a data field's long format by performing one of the following three actions:

- Click the **small triangle** in the left corner.
- Double-click anywhere in the data field.
- Click once in the Data Field with the left mouse button, then choose **Expand Data** from the pop-up menu.



A repeat of any above methods causes the display to return to a Short Data format.

6.3 Resizing Cells

Data cells can be resized by pointing the mouse pointer on the edge of a data cell, depressing and holding the left mouse button, and then repositioning the mouse pointer while keeping the mouse button depressed.

6.4 Pop-up Menus

The Analyzer software makes extensive use of pop-up menus. In some instances, pop-up menus provide the only means of accessing dialogs that contain detailed information about cells within the CATC Trace, for example, the Show Configuration Space dialog.

To see a pop-up menu, left-click or right-click a **cell** within the CATC Trace. Right-click or left-click behavior depends on the Display Options setting. For default left-click, the right-click menu is not cell-dependent. For other left-click behavior, the type of menu that opens varies depending on the type of cell that is selected. Take some time to explore CATC Traces and the various pop-up menus.

6.5 View Data Block

To view the raw bits that make up the data in a data field, left-click a data field, then click or select **View Data Block** from the pop-up menu to display the Data Block window

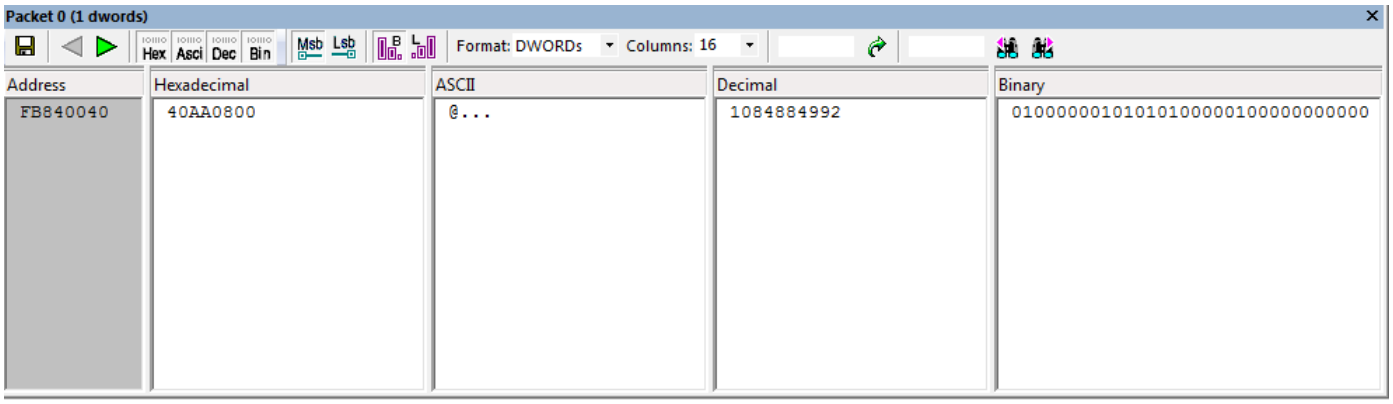


Figure 6.1: Viewing a Data Block

You can display data in Hexadecimal, ASCII, Decimal, or Binary formats.

Bit Order is Most Significant Bit or Least Significant Bit.

You can display data in Big Endian or Little Endian.

Format lets you display data as BYTEs, WORDs, or DWORDs.

Columns lets you select the number of columns.

You can enter hexadecimal offset values.

You can go to or search Previous or Next.

6.6 Show Raw 10b Codes

You can view the raw bits that make up the data field by right-clicking the field and selecting **Show Raw 10b Codes** from the pop-up menu.

To view Raw 10b Codes:

1. Right-click the **first cell** in a packet.
2. Select **Show Raw 10b Codes** from the pop-up menu to display the Raw 10b Codes window

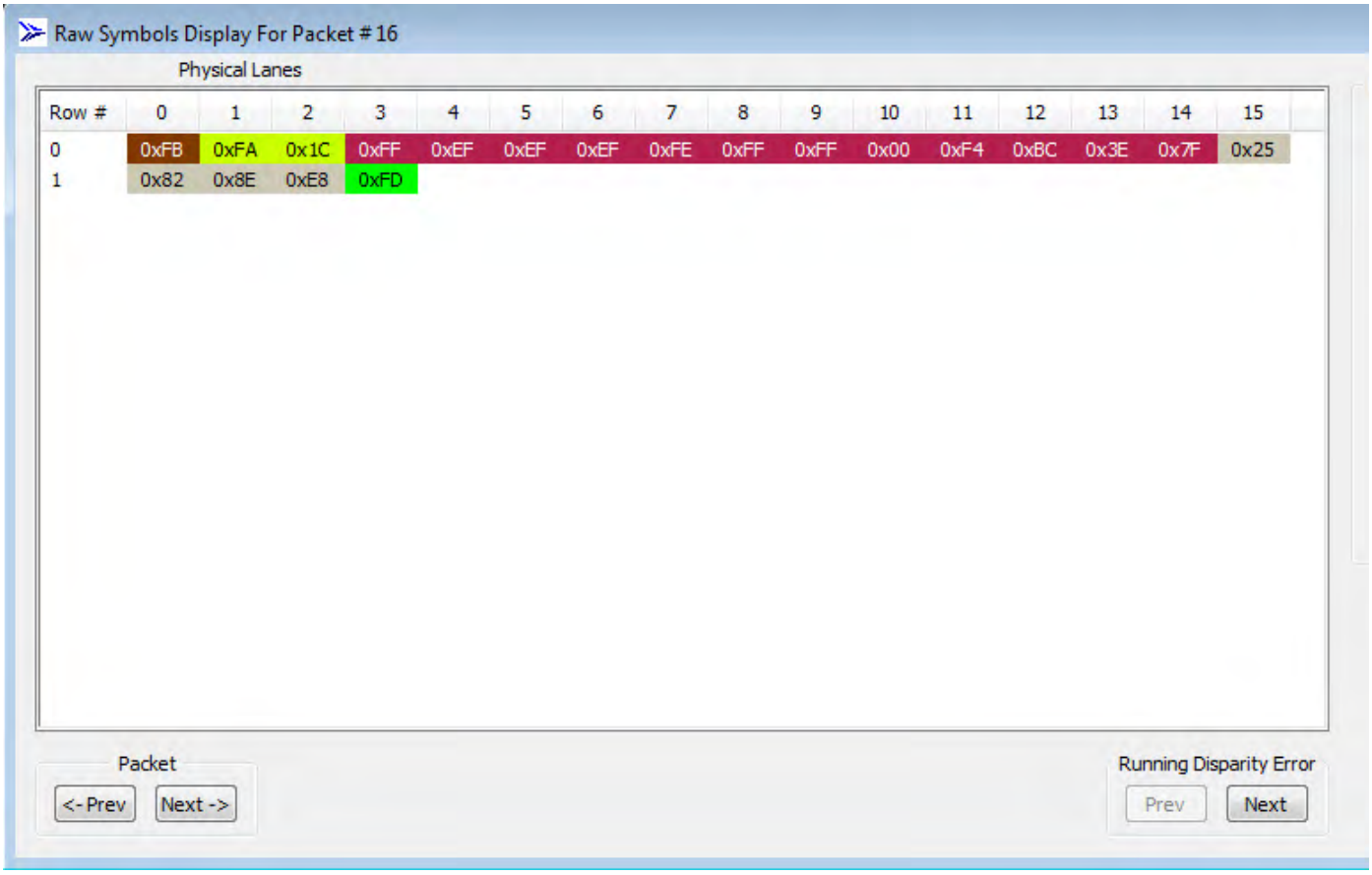

Raw Symbols Display For Packet # 16
Physical Lanes
Row # 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 0xFB 0xFA 0x1C 0xFF 0xEF 0xEF 0xEF 0xFE 0xFF 0xFF 0x00 0xF4 0xBC 0x3E 0x7F 0x25
1 0x82 0x8E 0xE8 0xFD
Packet
<- Prev
Next ->
Running Disparity Error
Prev
Next

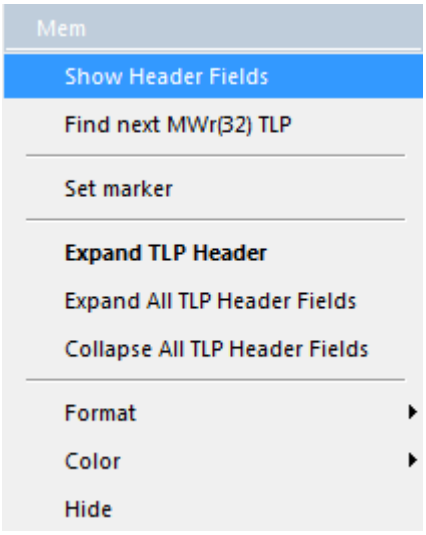
Figure 6.2: Show Raw 10b Codes Dialog

3. To change the format of the data, use the options along the right side of the dialog.
4. To navigate the CATC Trace, use the **Prev** and **Next** buttons.

6.7 Show Header Fields

You can view details about header fields by opening the Show Header Fields dialog.

1. Click a **header.** A pop-up menu displays.



2. Select **Show Header Fields**. The following dialog opens.

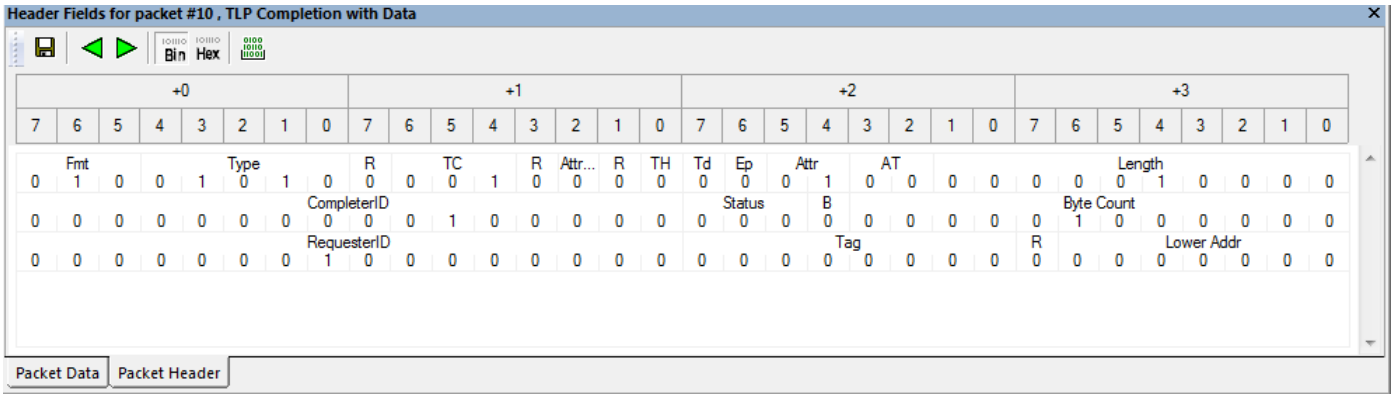
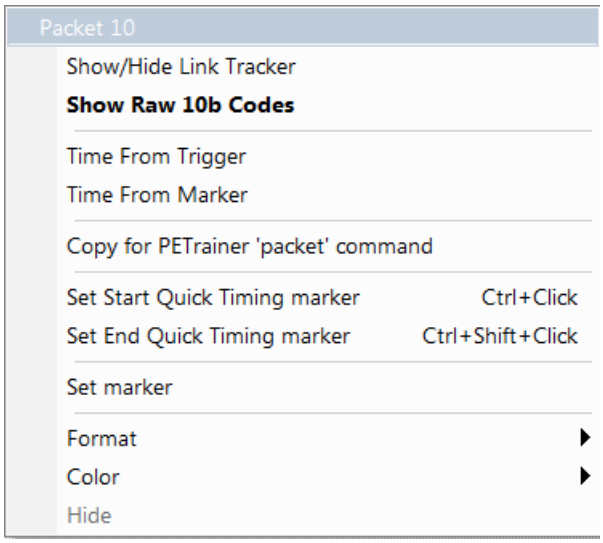


Figure 6.3: Viewing Packet Fields

3. Use the **Prev** and **Next** buttons to navigate to other headers.

6.8 Packet Cell Popup Menus

The Packet cell has a right-click pop-up menu that includes the Show Raw 10b Codes command:

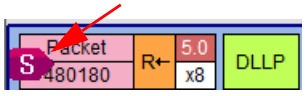


6.8.1 Set Start Quick Timing Marker

Sets the start packet for the Quick Timing marker. An S symbol is displayed at the packet.

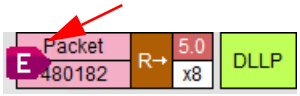
Quick Timing provides immediate time deltas and bandwidth calculations. If the Start is placed on a packet that contains an Address and Endpoint, the bandwidth for that combination is displayed in the Status Bar below the trace data.

Quick Timing Markers are special ""Start"" and ""End"" markers used to mark the boundaries of the calculations. The results are shown in a special Quick Timing Bar at the bottom of the TraceView. The markers are set from a context sensitive menu.



6.8.2 Set End Quick Timing Marker

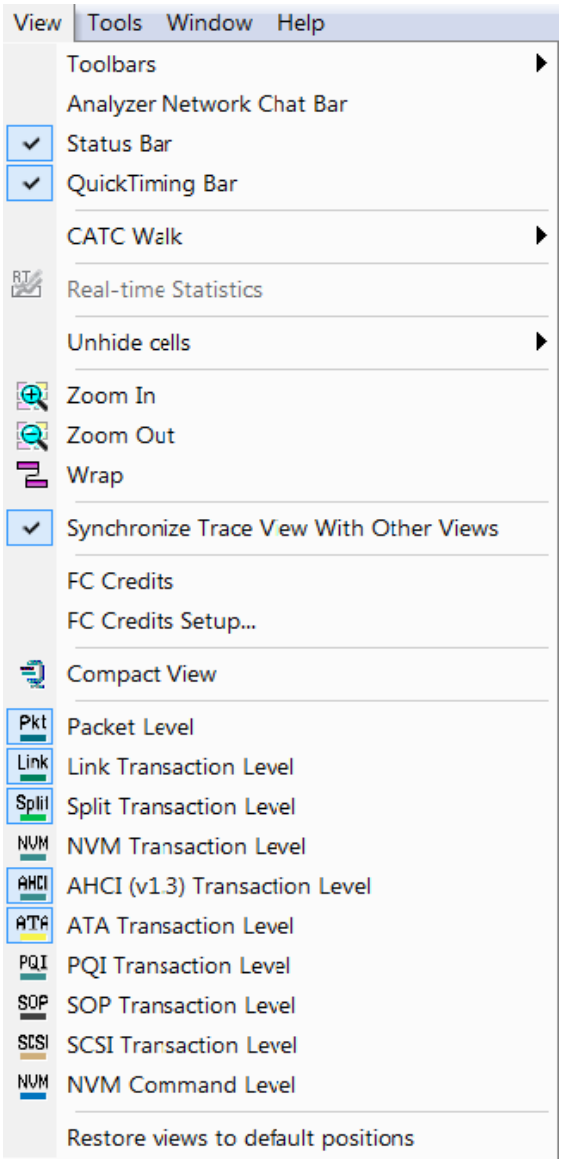
Sets the end packet for the Quick Timing marker. An E symbol is displayed at the packet.



6.8.3 Delete All Quick Timing Marker

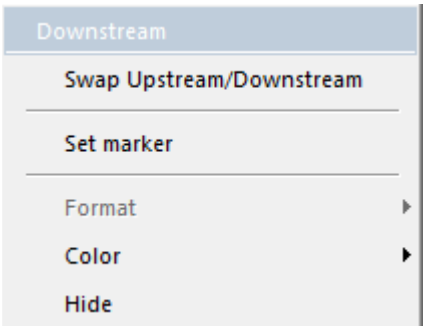
Deletes all Quick Timing markers.

The right-click pop-up menu from Packet cell is displayed below:



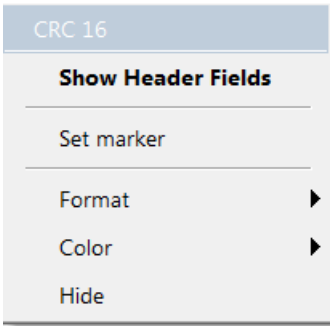
6.8.4 Packet Header R-> Cell Popup Menu

The Packet Header R-> cell has a pop-up menu with the Swap Upstream/Downstream command, which changes the directionality of the packets in the CATC Trace.



6.8.5 Packet Header G1 Cell Popup Menu

The Packet Header G1 cell has a pop-up menu with the Show Header Fields command (see “Show Header Fields” on page 124), which exposes a detailed view of the selected Header field (see the following figure).

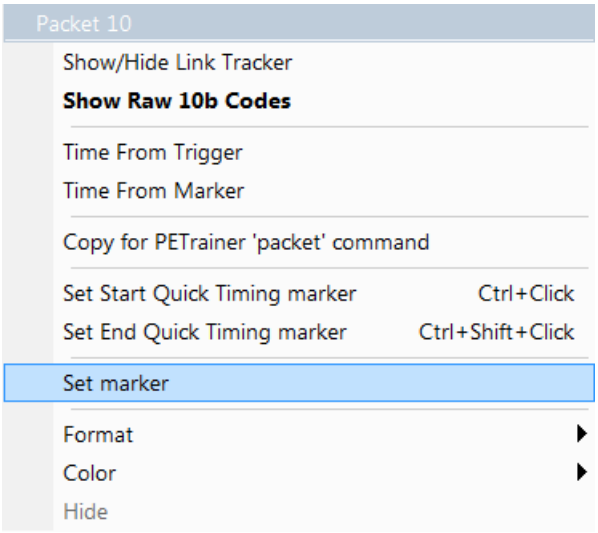


6.9 Set Marker

A marker is a unique label for a packet that allows you to go to that packet and also serves as a **comment string** for a specific packet. When you select a marker, the identified packet appears at the top of the screen. Packets that have been **marked** have a red bar on the left edge.

To set a marker, perform the following steps:

1. Left-click the **Packet** field of the packet you want to mark (see the following screen) or hover over the packet and click **Ctrl+K,** or select the packet and click **Ctrl+L**.



2. Click **Set Marker**.
3. When the Create Marker for Packet # pop-up (see Figure 6.4 on page 128), enter a unique identifier for the packet in the Comment field.

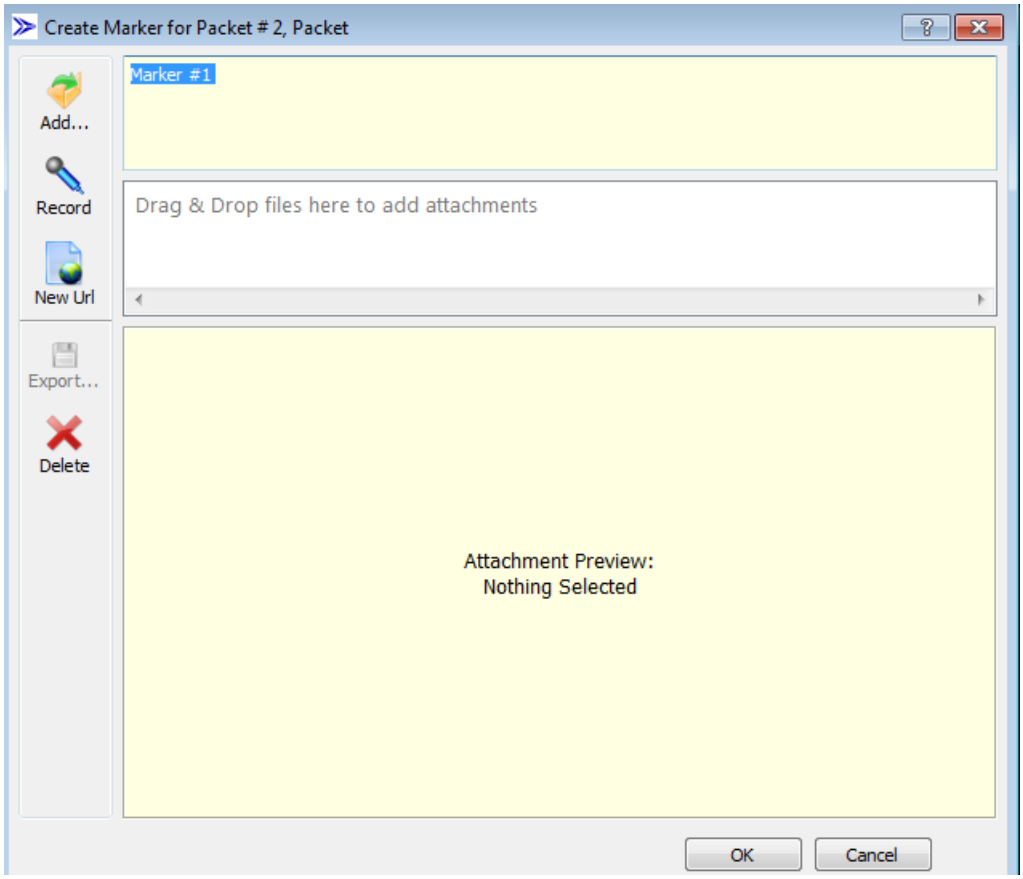


Figure 6.4: Create Marker for Packet Dialog

Later, you can go directly to this packet using the Go To Marker operation in the Search Menu.

6.10 Edit or Clear Marker

To change a markers identifier, or clear (delete) the marker:

1. Left-click the **Packet** field of the desired packet to display a pop-up menu (see Figure 6.5 on page 129).

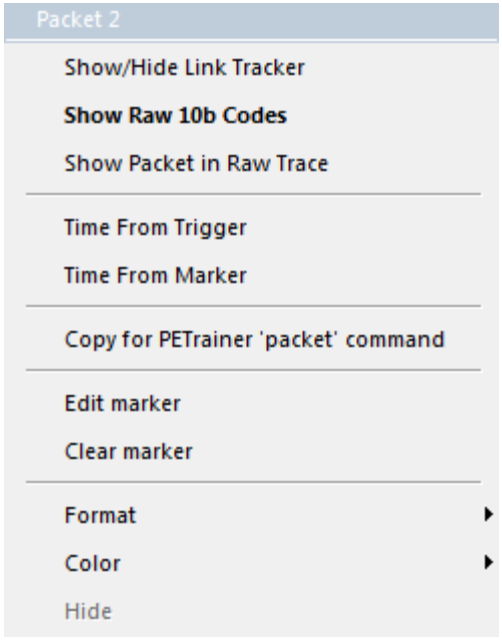


Figure 6.5: Edit Marker Pop-up Menu

Choose **Edit Marker** and enter a new identifier into the Edit Marker for Packer # pop-up, or
Choose **Clear Marker**. When you choose Clear Marker, the marker is removed and the red line disappears.

6.11 Compressed CATC Trace View

The Compressed CATC Trace view shows fields in the format “Attribute: Value”, whereas the normal CATC View shows the attribute name on top and the value below.

The Compressed CATC Trace view has almost all the information of the normal CATC View and behaves mostly the same way, while displaying more information on each window (see Figure 6.6 on page 130).

To compress the CATC Trace:

- Click on the toolbar.

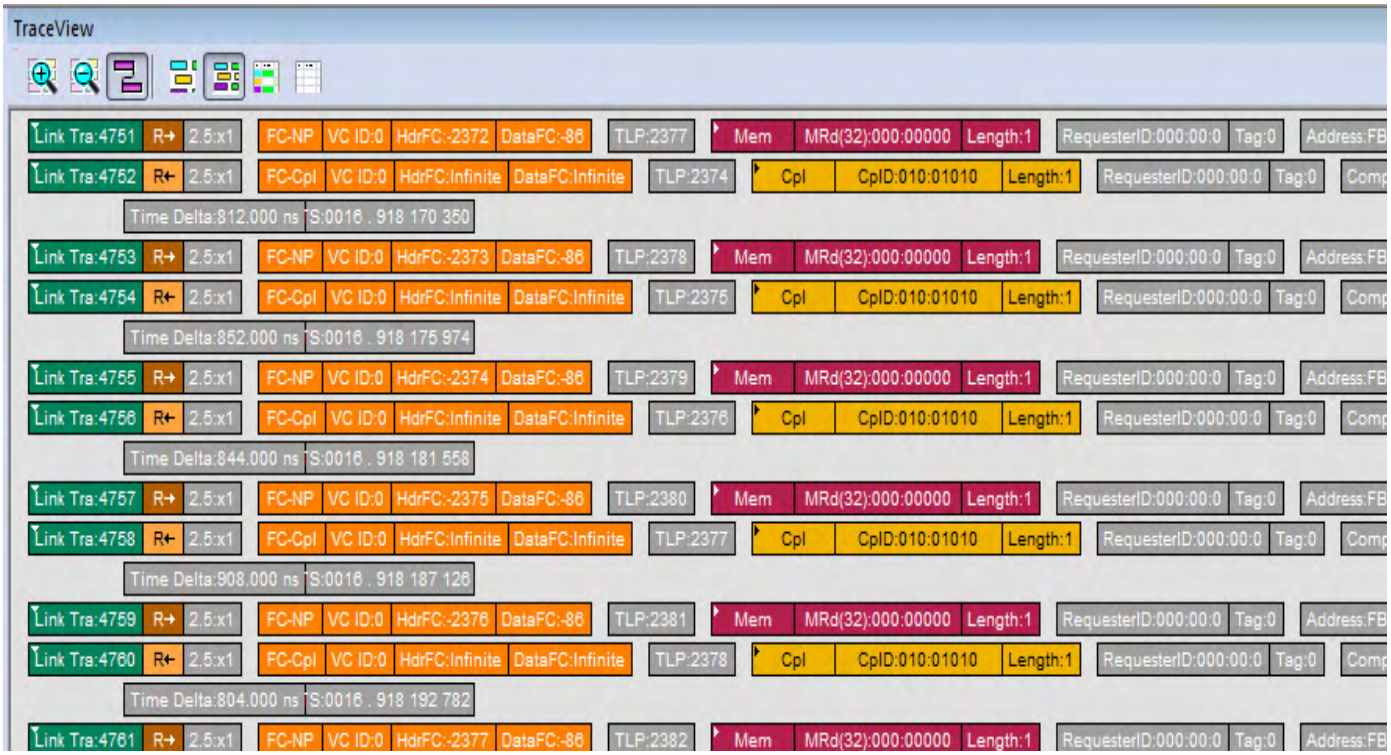

TraceView
Link Tra:4751 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2372 DataFC:-86 TLP:2377 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE
Link Tra:4752 R← 2.5:x1 FC-Cpl VC ID:0 HdrFC:Infinite DataFC:Infinite TLP:2374 Cpl CplD:010:01010 Length:1 RequesterID:000:00:0 Tag:0
Time Delta:812.000 ns S:0016 . 918 170 350
Link Tra:4753 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2373 DataFC:-86 TLP:2378 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE
Link Tra:4754 R← 2.5:x1 FC-Cpl VC ID:0 HdrFC:Infinite DataFC:Infinite TLP:2375 Cpl CplD:010:01010 Length:1 RequesterID:000:00:0 Tag:0
Time Delta:852.000 ns S:0016 . 918 175 974
Link Tra:4755 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2374 DataFC:-86 TLP:2379 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE
Link Tra:4756 R← 2.5:x1 FC-Cpl VC ID:0 HdrFC:Infinite DataFC:Infinite TLP:2376 Cpl CplD:010:01010 Length:1 RequesterID:000:00:0 Tag:0
Time Delta:844.000 ns S:0016 . 918 181 558
Link Tra:4757 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2375 DataFC:-86 TLP:2380 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE
Link Tra:4758 R← 2.5:x1 FC-Cpl VC ID:0 HdrFC:Infinite DataFC:Infinite TLP:2377 Cpl CplD:010:01010 Length:1 RequesterID:000:00:0 Tag:0
Time Delta:908.000 ns S:0016 . 918 187 126
Link Tra:4759 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2376 DataFC:-86 TLP:2381 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE
Link Tra:4760 R← 2.5:x1 FC-Cpl VC ID:0 HdrFC:Infinite DataFC:Infinite TLP:2378 Cpl CplD:010:01010 Length:1 RequesterID:000:00:0 Tag:0
Time Delta:804.000 ns S:0016 . 918 192 782
Link Tra:4761 R→ 2.5:x1 FC-NP VC ID:0 HdrFC:-2377 DataFC:-86 TLP:2382 Mem MRd(32):000:00000 Length:1 RequesterID:000:00:0 Tag:0 Address:FE

Figure 6.6: Compressed CATC Trace

- Click on the toolbar to return to the normal CATC Trace View, or Select **View > Trace Views > CATC Trace.**

6.12 Spreadsheet View

You can view the CATC Trace as a spreadsheet in color or black and white.

Click on the toolbar to display the Spreadsheet View (see Figure 6.7 on page 131).

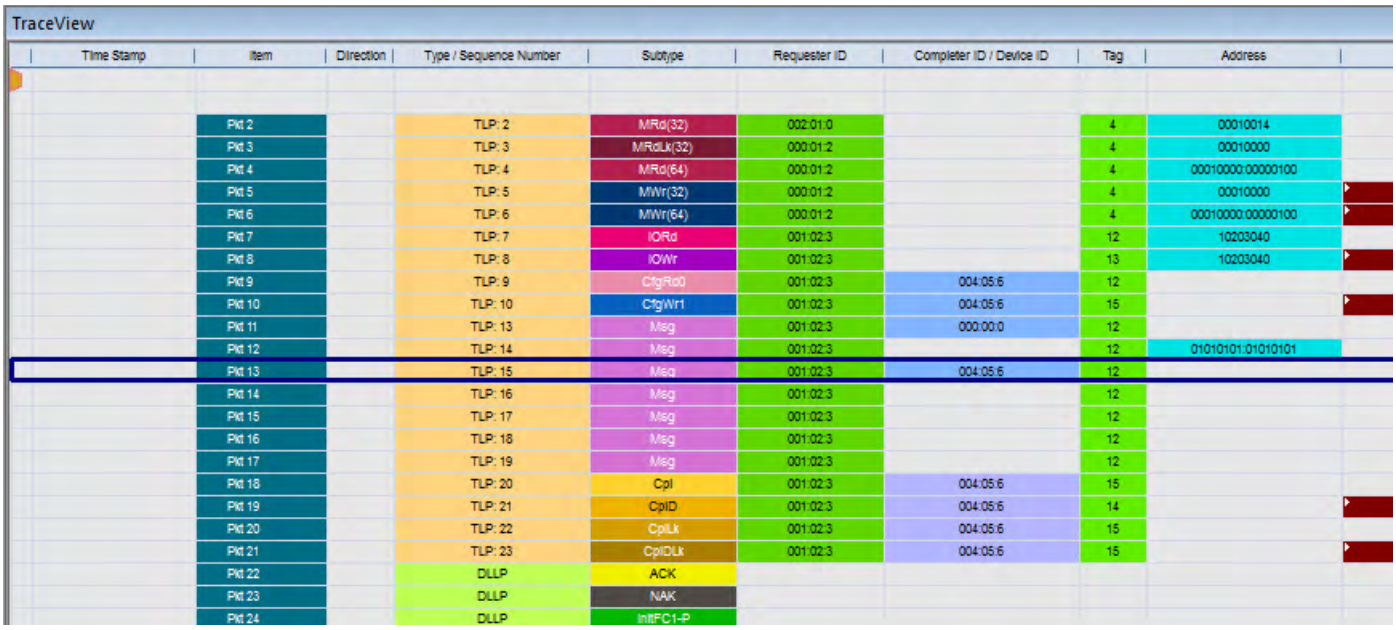


Figure 6.7: Spreadsheet View (Color)

- Click on the toolbar to display the Spreadsheet View B/W.

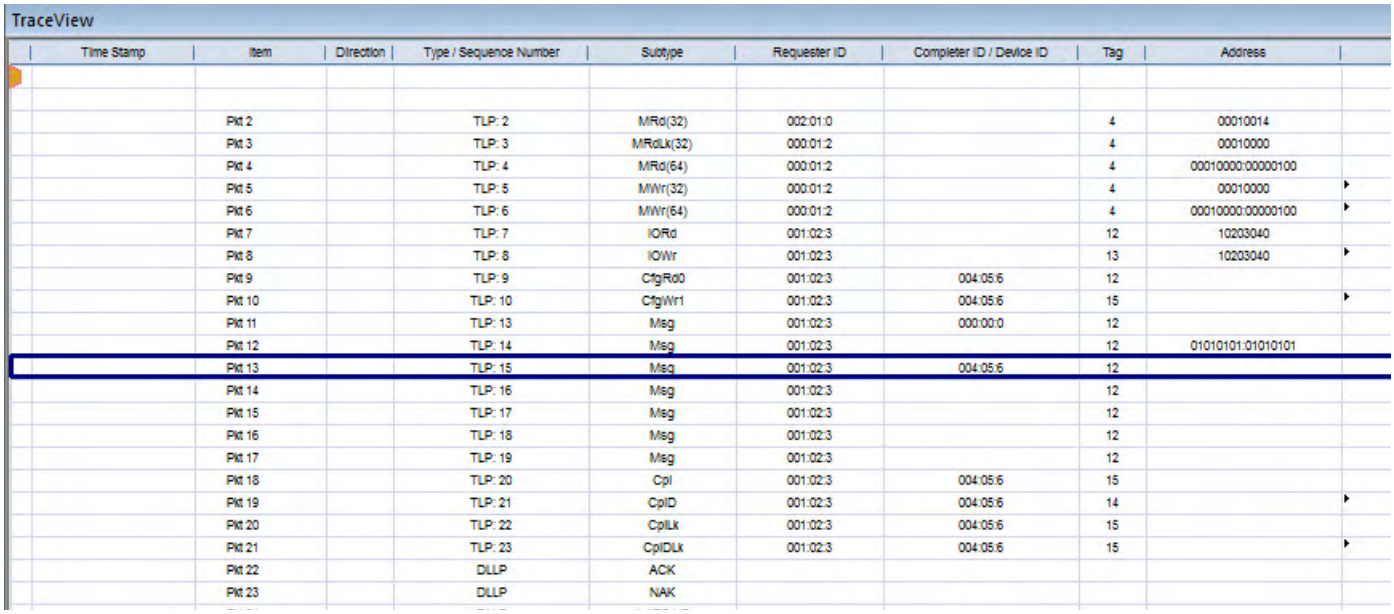


Figure 6.8: Spreadsheet View (Black And White)

6.12.1 Columns

To add a column, right-click a column header, select **Add Column,** and then select the column name.

To delete a column, right-click a column header and then select **Remove Column**.

To reposition a column, drag the column header to the new position.

To resize columns, select the column divider and drag the divider to the right or left.

Each of the SSD options (NVMe, PQI, AHCI, ATA, SOP, SCSI) can be viewed and has its own customizable column configuration. The figure below shows the NVMe transaction level.

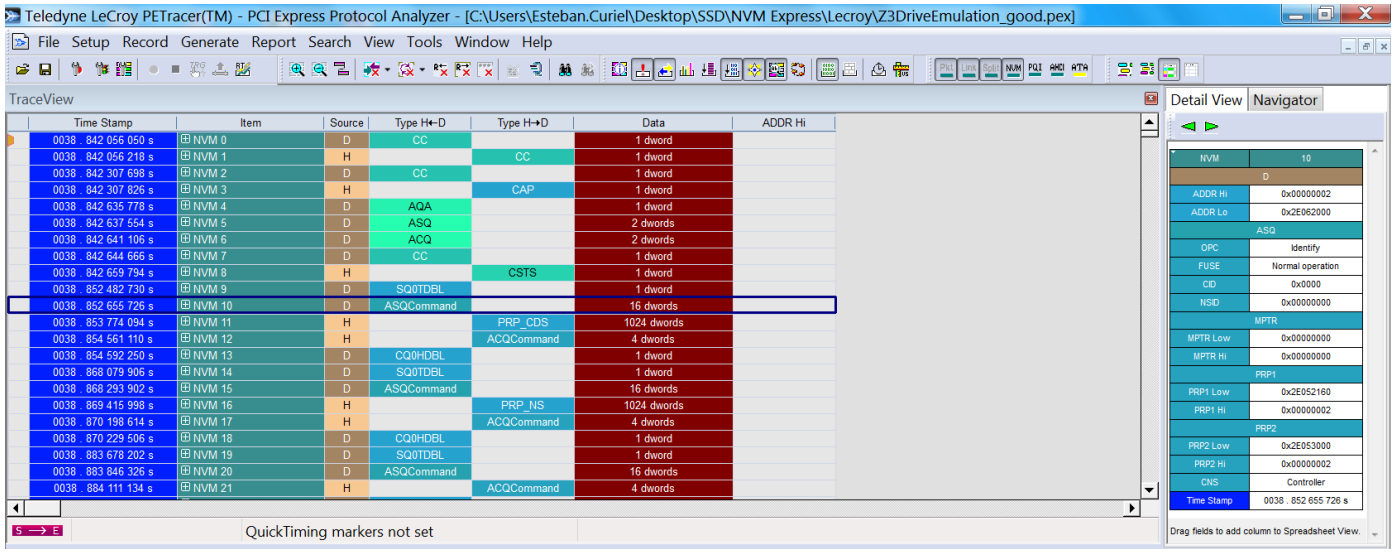


Figure 6.9: NVMe Transaction Level

Restore Factory Default Settings

You can use one of the following three methods to restore the columns to the factory default settings:

- Right-click the column header and select **Restore default columns** to display a confirmation dialog. Click **Yes** to restore for selected transaction level.

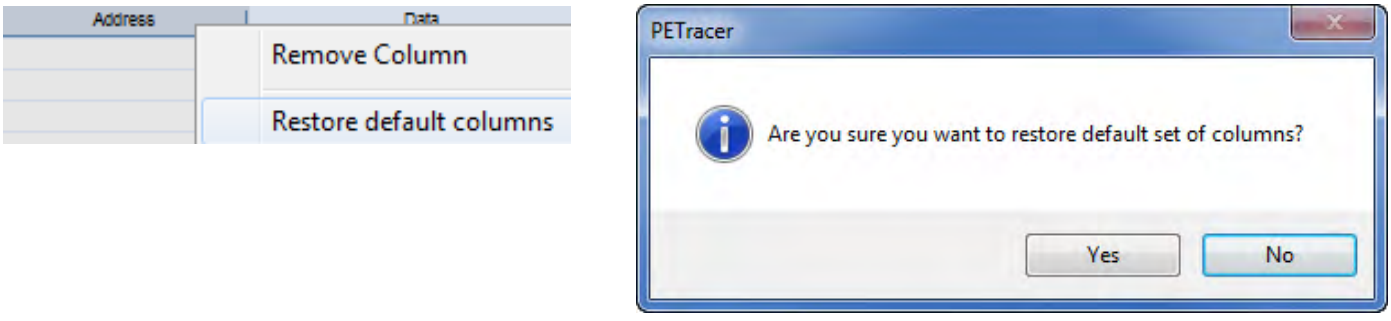


Figure 6.10: Right-click Header Restore Default Columns Dialogs

- Right-click in the empty space and select **Restore views to default positions** to display a confirmation dialog. Click **Yes** to restore for specific transaction level.

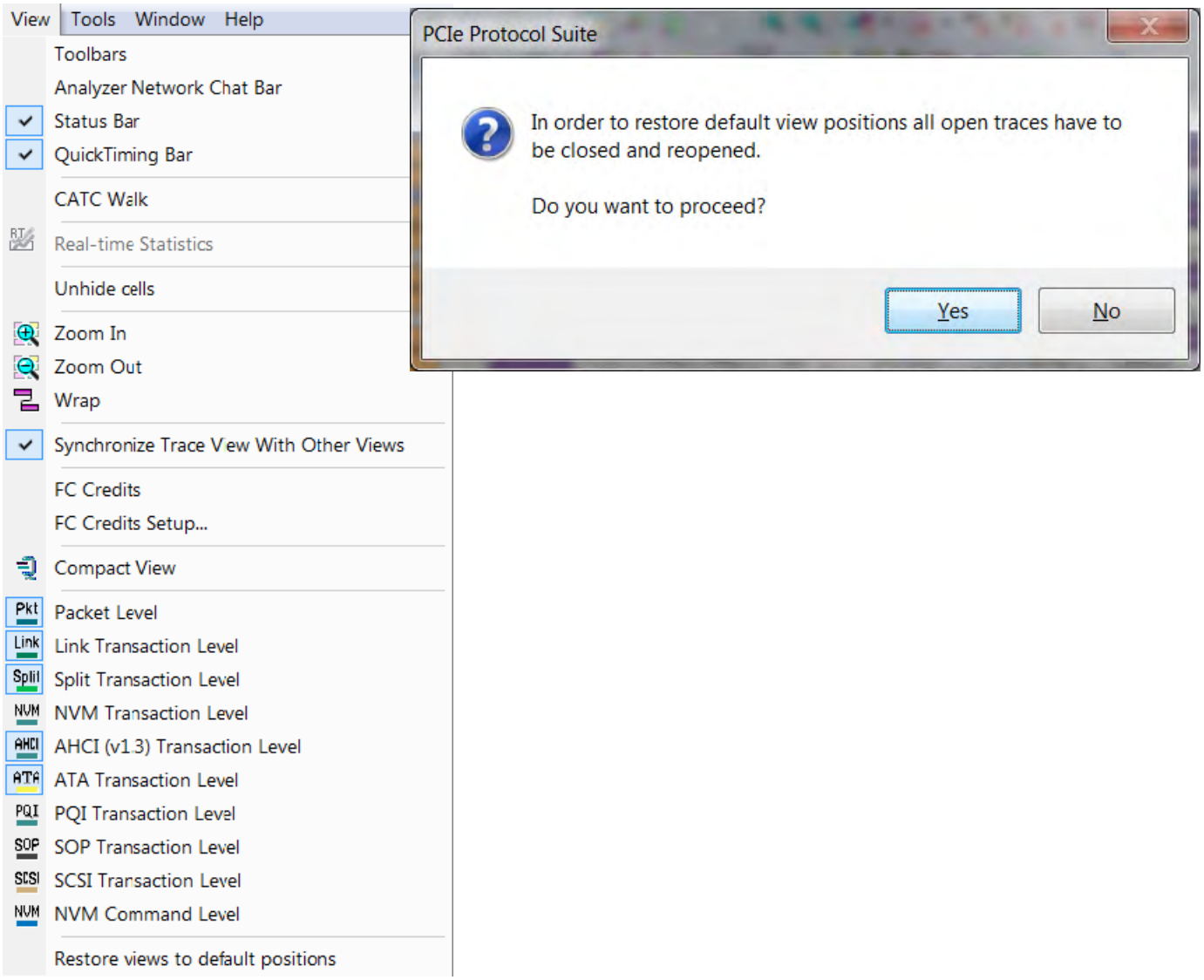


Figure 6.11: Right-click Empty Space Restore Views to Default Positions Dialogs

- Select **Setup > Display Options** to display the Display Options dialog. Click **Restore Factory Settings**.

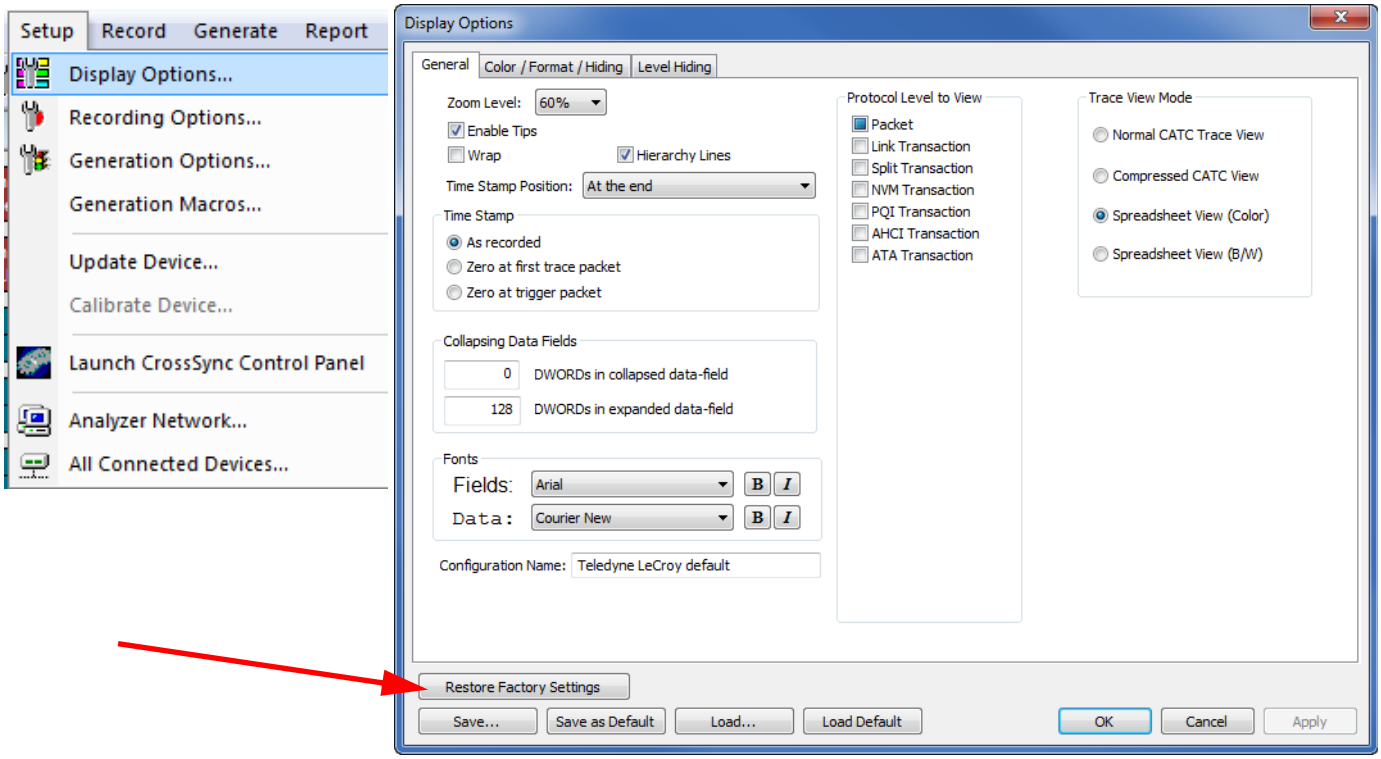


Figure 6.12: Setup and Display Options Dialog

6.12.2 Detail View and Spreadsheet View

In the Spreadsheet View, double-click a packet, transaction, or transfer, or select a field and then click on the toolbar, to display the Detail View.

To put a Detail View header as a column in the Spreadsheet View, drag the header to a column divider in the Spreadsheet View (see Figure 6.13 on page 134).

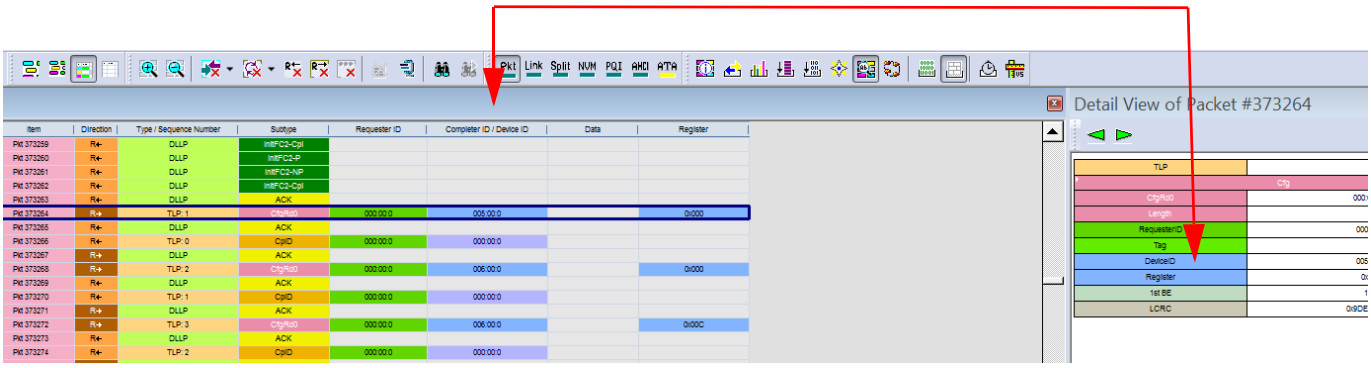


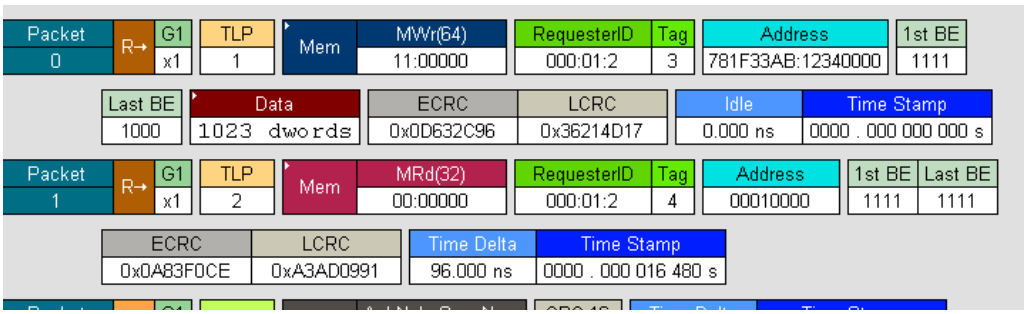
Figure 6.13: Detail View in Spreadsheet View

6.13 Decoding Traffic

The PCIe Protocol Suite software has several decode levels:

6.13.1 Packet

Packet level decode includes all TLP packets, DLLP packets, and all ordered sets.



Note: The PCI-E 3.0 (and 2.1 with Errata) specifications state that there are two formats of the AER capability structure, and the AER_CAP_VER field indicates if format 1 or format 2 is used.

The difference between format 1 and format 2 is whether or not the TLP Prefix Header section is present in the AER capability, even if it is not actually implemented.

This means that:

- If AER_CAP_VER = 1 and it is not a Root Port or RC Event Collector, there are 11 DWs (00h to 24h)in the total AER Capability structure.
- If AER_CAP_VER = 1 and it is a Root Port or RC Event Collector, there are 14 DWs (00h to 34h)in the total AER Capability structure.
- If AER_CAP_VER = 2 then, there are 18 DWs (00h to 44h) in the total AER Capability structure.

In fact, there are PCI-E 3.0 compliant devices that have AER_CAP_VER=1.

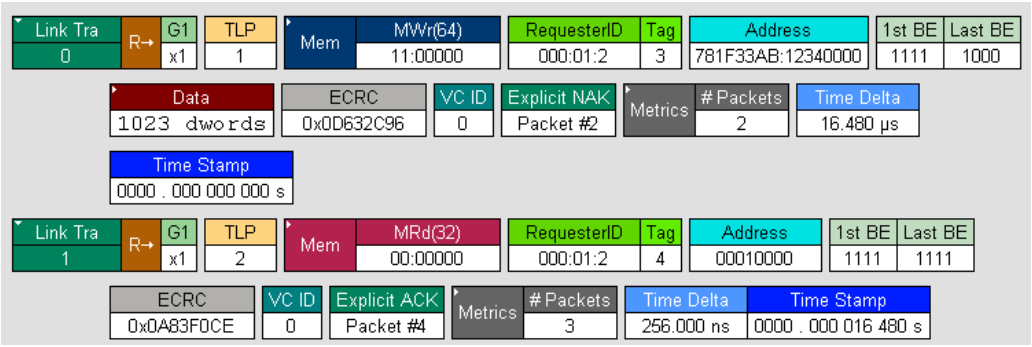
Example H/W:

A PCI-E 3.0 device that supports Multiple Header Recording, but does NOT support TLP Prefixes. This device is allowed to have AER_CAP_VER=1, and Multiple_Header_Recording_Capable=1

Therefore, the Teledyne LeCroy software decodes the Multiple_Header_Recording_Capable field regardless of the value of AER_CAP_VER.

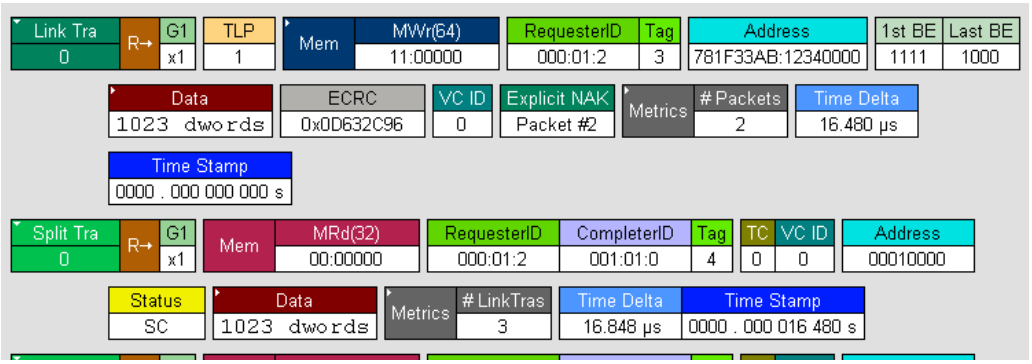
6.13.2 Link

Link level decode is composed of TLP packets matched with a corresponding ACK or NAK coming from the opposite direction.



6.13.3 Split

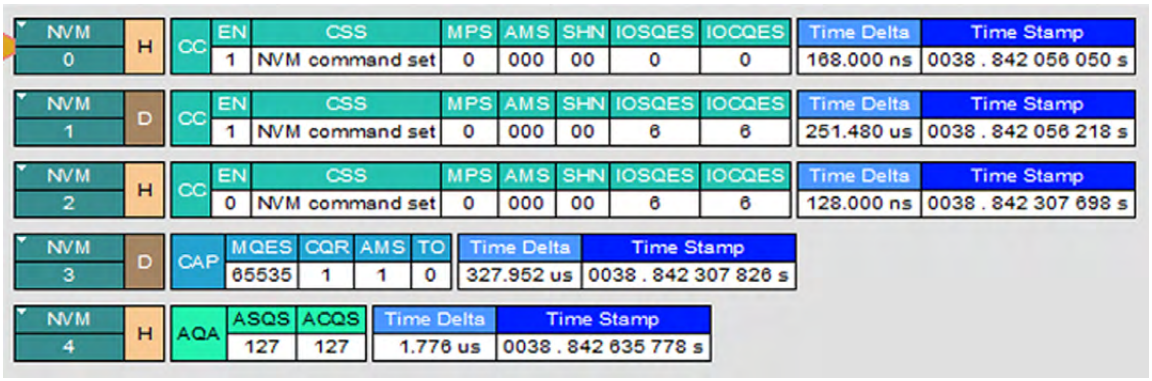
Split level decode is composed of two Link transactions, the Request TLP and the Completion TLP from the other direction.



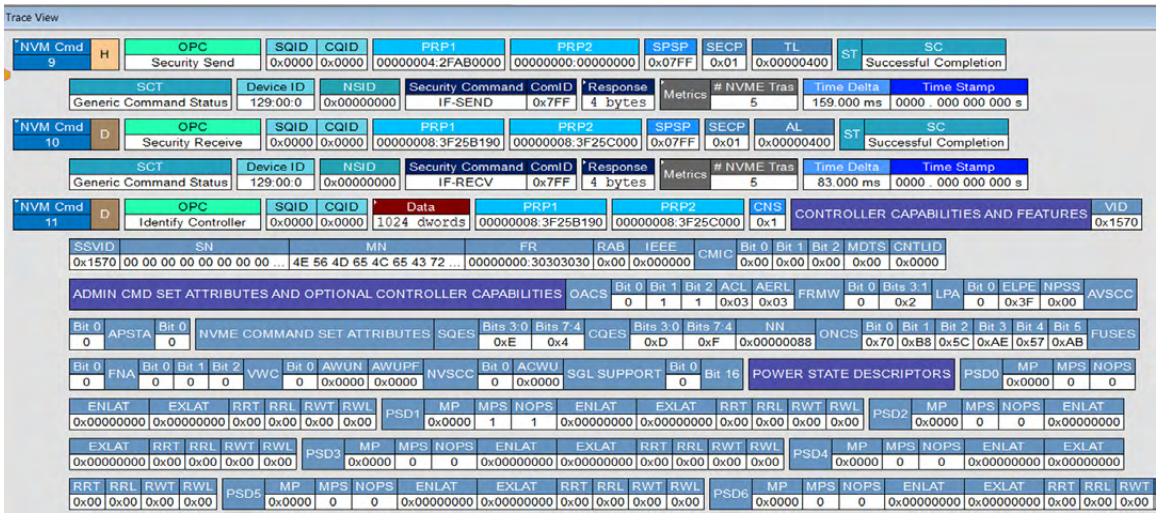
6.13.4 NVMe

To decode the NVMe protocol there are two levels available: NVMe Transaction level, which decodes the individual NVMe transactions from the PCI Express protocol and NVMe Command level, which gathers NVMe transactions into a single command. If the top level button is selected, it will decode the NVMe Command level directly.

The NVMe Transaction level option displays NVMe transactions. PCIe Protocol Suite decodes the storage commands starting from lower PCI Express Transaction Layer decodes. In the case of NVMe, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the NVMe Transaction decode level.


NVM 0 H CC EN 1 CSS NVM command set MPS 0 AMS 000 SHN 00 IOSQES 0 IOCQES 0 Time Delta 168.000 ns Time Stamp 0038 . 842 056 050 s
NVM 1 D CC EN 1 CSS NVM command set MPS 0 AMS 000 SHN 00 IOSQES 6 IOCQES 6 Time Delta 251.480 us Time Stamp 0038 . 842 056 218 s
NVM 2 H CC EN 0 CSS NVM command set MPS 0 AMS 000 SHN 00 IOSQES 6 IOCQES 6 Time Delta 128.000 ns Time Stamp 0038 . 842 307 698 s
NVM 3 D CAP MQES 65535 CQR 1 AMS 1 TO 0 Time Delta 327.952 us Time Stamp 0038 . 842 307 826 s
NVM 4 H AQA ASQS 127 ACQS 127 Time Delta 1.776 us Time Stamp 0038 . 842 635 778 s

The NVMe Command level option displays NVMe Commands. The NVME commands decode all the lower level decodes first.


Trace View
NVM Cmd 9 H OPC Security Send SQID 0x0000 CQID 0x0000 PRP1 00000004:2FAB0000 PRP2 00000000:00000000 SPSP 0x07FF SECP 0x01 TL 0x00000400 ST SC Successful Completion
SCT Generic Command Status Device ID 129:00:0 NSID 0x00000000 Security Command ComID IF-SEND 0x7FF Response 4 bytes Metrics # NVME Tras 5 Time Delta 159.000 ms Time Stamp 0000 . 000 000 000 s
NVM Cmd 10 D OPC Security Receive SQID 0x0000 CQID 0x0000 PRP1 00000008:3F25B190 PRP2 00000008:3F25C000 SPSP 0x07FF SECP 0x01 AL 0x00000400 ST SC Successful Completion
SCT Generic Command Status Device ID 129:00:0 NSID 0x00000000 Security Command ComID IF-RECV 0x7FF Response 4 bytes Metrics # NVME Tras 5 Time Delta 83.000 ms Time Stamp 0000 . 000 000 000 s
NVM Cmd 11 D OPC Identify Controller SQID 0x0000 CQID 0x0000 Data 1024 dwords PRP1 00000008:3F25B190 PRP2 00000008:3F25C000 CNS 0x1 CONTROLLER CAPABILITIES AND FEATURES VID 0x1570
SSVID 0x1570 SN 00 00 00 00 00 00 00 00 ... MN 4E 56 4D 65 4C 65 43 72 ... FR 00000000:30303030 RAB 0x00 IEEE 0x000000 CMIC Bit 0 0x00 Bit 1 0x00 Bit 2 0x00 MDTS 0x00 CNTLID 0x0000
ADMIN CMD SET ATTRIBUTES AND OPTIONAL CONTROLLER CAPABILITIES OACS Bit 0 0 Bit 1 1 Bit 2 1 ACL 0x03 AERL 0x03 FRMW Bit 0 0 Bits 3:1 0x2 LPA Bit 0 0 ELPE 0x3F NPSS 0x00 AVSCC
Bit 0 0 APSTA Bit 0 0 NVME COMMAND SET ATTRIBUTES SQES Bits 3:0 0xE Bits 7:4 0x4 CQES Bits 3:0 0xD Bits 7:4 0xF NN 0x00000088 ONCS Bit 0 0x70 Bit 1 0xB8 Bit 2 0x5C Bit 3 0xAE Bit 4 0x57 Bit 5 0xAB FUSES
Bit 0 0 FNA Bit 0 0 Bit 1 0 Bit 2 0 VWC Bit 0 0 AWUN 0x0000 AWUPF 0x0000 NVSCC Bit 0 0 ACWU 0x0000 SGL SUPPORT Bit 0 0 Bit 16 POWER STATE DESCRIPTORS PSD0 MP 0x0000 MPS 0 NOPS 0
ENLAT EXLAT RRT RRL RWT RWL PSD1 MP 0x0000 MPS 1 NOPS 1 ENLAT 0x00000000 EXLAT 0x00000000 RRT 0x00 RRL 0x00 RWT 0x00 RWL 0x00 PSD2 MP 0x0000 MPS 0 NOPS 0 ENLAT 0x00000000
EXLAT RRT RRL RWT RWL PSD3 MP 0x0000 MPS 0 NOPS 0 ENLAT 0x00000000 EXLAT 0x00000000 RRT 0x00 RRL 0x00 RWT 0x00 RWL 0x00 PSD4 MP 0x0000 MPS 0 NOPS 0 ENLAT 0x00000000 EXLAT 0x00000000
RRT RRL RWT RWL PSD5 MP 0x0000 MPS 0 NOPS 0 ENLAT 0x00000000 EXLAT 0x00000000 RRT 0x00 RRL 0x00 RWT 0x00 RWL 0x00 PSD6 MP 0x0000 MPS 0 NOPS 0 ENLAT 0x00000000 EXLAT 0x00000000 RRT 0x00 RRL 0x00 RWT 0x00

Note: As of software version 7.34, the NVMe decoding will be performed properly even if the ACK DLLPs have been filtered.

Note: As of software version 7.34, once the NVMe decoding has been applied, it will be kept in a separate temporary file not the Trace file (see "Trace File Structure" on page 47). The next time the trace is opened for review there will be no need to re-decode, making opening of the file in NVMe mode faster.

Note: As of software version 7.36 Beta, the NVMe decoding can handle multiple controller resets within the same recording.

NVMe: Device ID and Model Name Decoded

As of software version 7.34, the Device ID and Device Model Name field is displayed in the decoded command (see Figure 6.14 and Figure 6.15 on page 139).

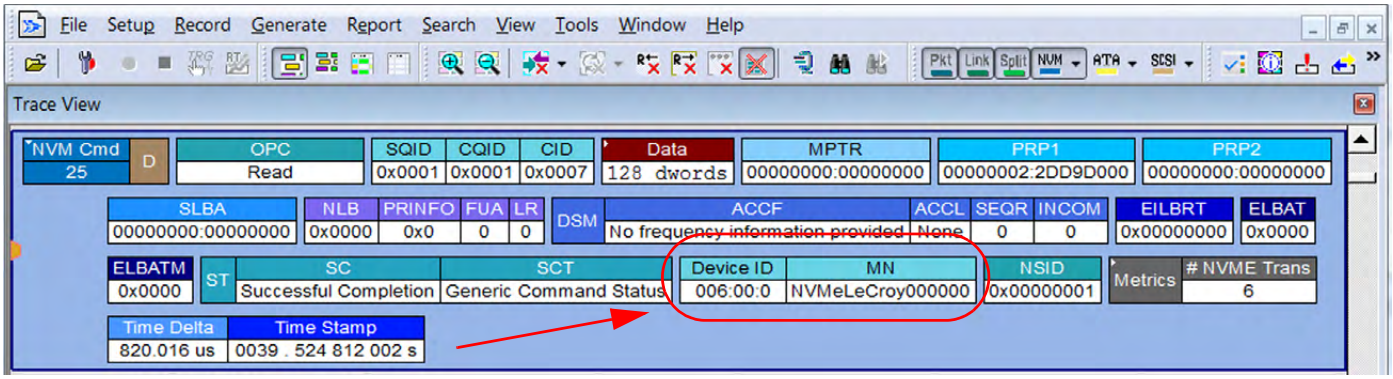


Figure 6.14: Device ID and Model Number Decoded from NVMe Trace

The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and NVMe transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu. See Figure 6.15 on page 139.

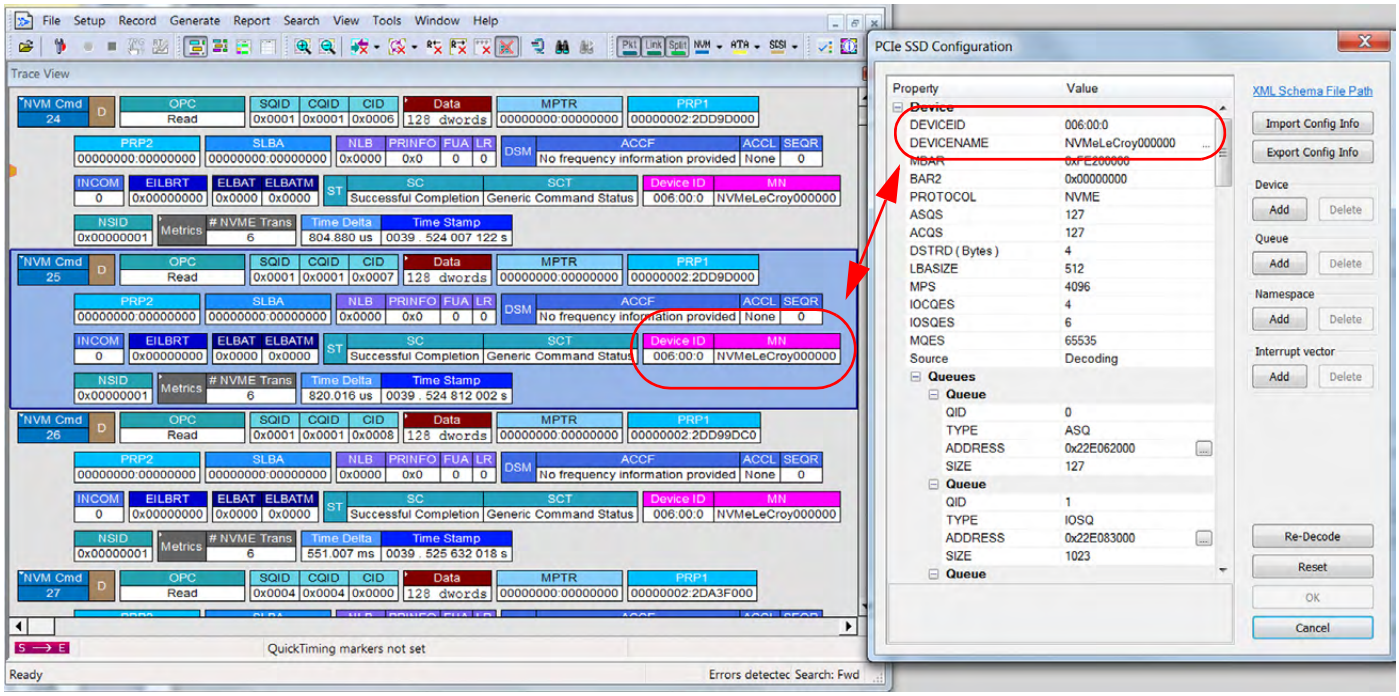
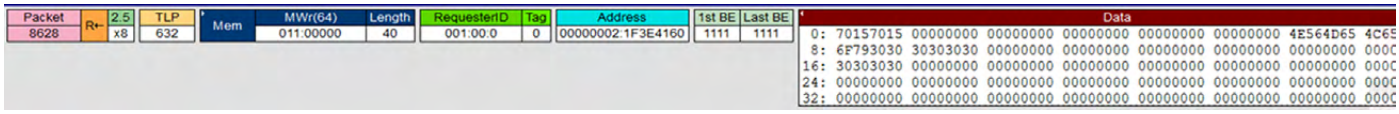


Figure 6.15: Device ID and Device Model Name Shown in SSD Configuration Dialog

NVMe: Data Field on Packets

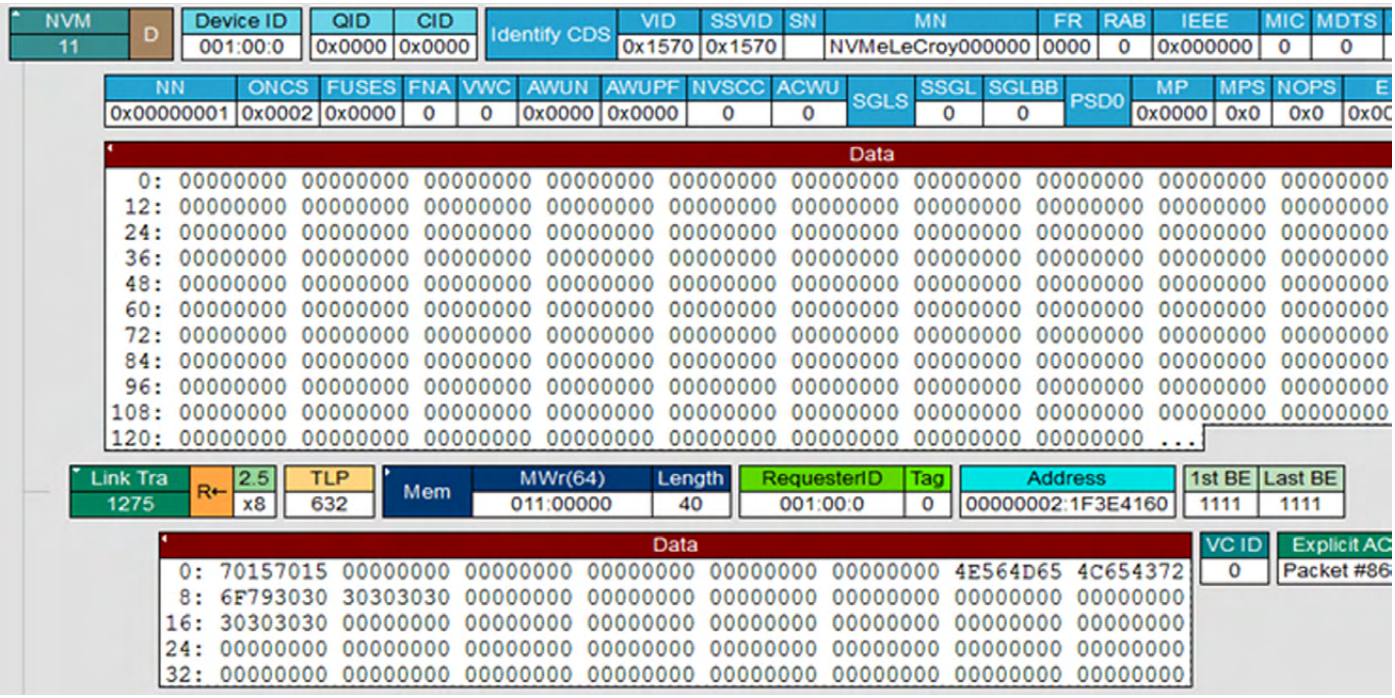
While the data field section displayed for a PCIe packet shows the actual payload for that PCIe packet (as shown below):



The content for this field changes depending on the decode level selected and the particular command decoded.

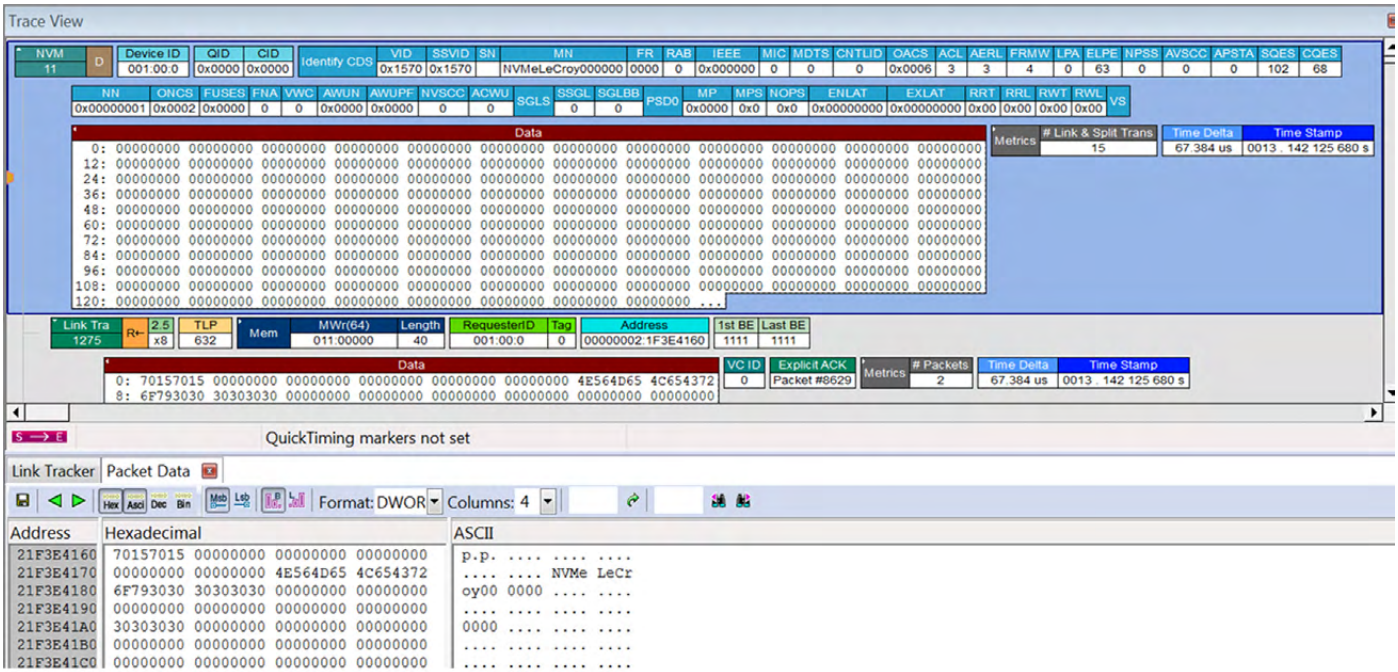
For example, at the PCIe transaction level, this field still reflects the PCIe payload field involved in the PCIe transaction (as shown below):

At the NVMe transaction level for identify command is shown below:



The data is shown according to NVMe specification. The portion of data that can be parsed into fields is parsed and drawn in named cells. The portion of data that cannot be parsed (i.e. 'vendor specific' portion is not parsed and is shown as a plain data).

In case you need to see this plain data (not parsed by named fields) the packet data view can be used. (as shown below):



NVMe: Trusted Computing Group Decode

Trusted Computing Group decodes will be shown using NVMe Command Level if they are present in the trace, as shown in Figure 6.16.

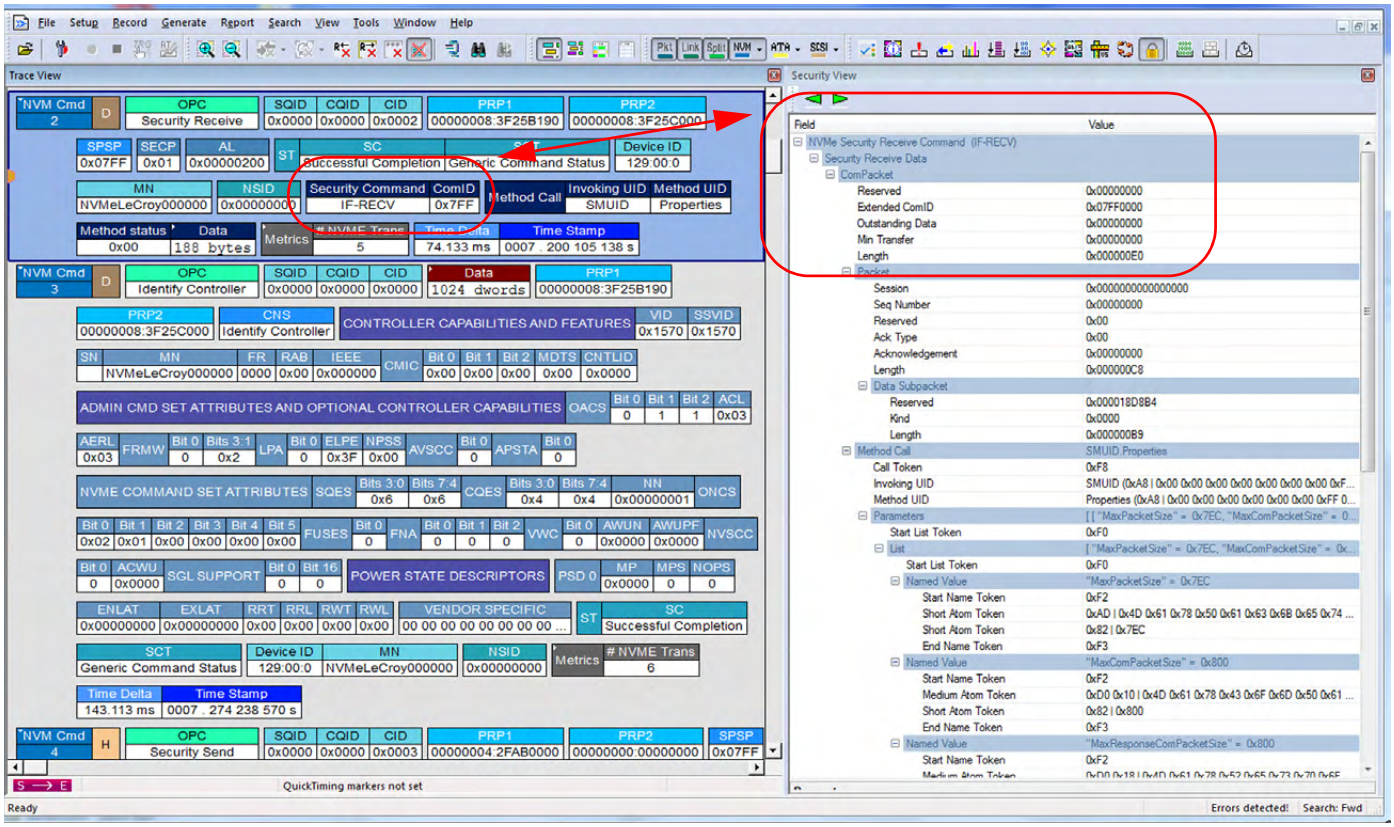

File Setup Record Generate Report Search View Tools Window Help
Trace View
Security View
NVM Cmd 2
OPC Security Receive
SQID CQID CID PRP1 PRP2
0x0000 0x0000 0x0002 00000008:3F25B190 00000008:3F25C000
SPSP SECP AL ST SC SCT Device ID
0x07FF 0x01 0x00000200 Successful Completion Generic Command Status 129:00:0
MN NSID Security Command ComID Method Call Invoking UID Method UID
NVMeLeCroy000000 0x00000000 IF-RECV 0x7FF SMUID Properties
Method status Data Metrics # NVME Trans Time Delta Time Stamp
0x00 188 bytes 5 74.133 ms 0007 . 200 105 138 s
NVM Cmd 3
OPC Identify Controller
SQID CQID CID Data PRP1
0x0000 0x0000 0x0000 1024 dwords 00000008:3F25B190
PRP2 CNS CONTROLLER CAPABILITIES AND FEATURES VID SSVID
00000008:3F25C000 Identify Controller 0x1570 0x1570
SN MN FR RAB IEEE CMIC MDTS CNTLID
NVMeLeCroy000000 0000 0x00 0x000000 0x00 0x0000
ADMIN CMD SET ATTRIBUTES AND OPTIONAL CONTROLLER CAPABILITIES OACS ACL
0x03
AERL FRMW LPA ELPE NPSS AVSCC APSTA
0x03 0x2 0x3F 0x00
NVME COMMAND SET ATTRIBUTES SQES CQES NN ONCS
0x6 0x6 0x4 0x4 0x00000001
FUSES FNA VWC AWUN AWUPF NVSCC
0x00 0x0000 0x0000
ACWU SGL SUPPORT POWER STATE DESCRIPTORS MP MPS NOPS
0x0000
ENLAT EXLAT RRT RRL RWT RWL VENDOR SPECIFIC ST SC
0x00000000 0x00000000 Successful Completion
SCT Device ID MN NSID Metrics # NVME Trans
Generic Command Status 129:00:0 NVMeLeCroy000000 0x00000000 6
Time Delta Time Stamp
143.113 ms 0007 . 274 238 570 s
NVM Cmd 4
OPC Security Send
SQID CQID CID PRP1 PRP2 SPSP
0x0000 0x0000 0x0003 00000004:2FAB0000 00000000:00000000 0x07FF
QuickTiming markers not set
Ready
Errors detected!
Search: Fwd
Field
Value
NVMe Security Receive Command (IF-RECV)
Security Receive Data
ComPacket
Reserved 0x00000000
Extended ComID 0x07FF0000
Outstanding Data 0x00000000
Min Transfer 0x00000000
Length 0x000000E0
Packet
Session 0x0000000000000000
Seq Number 0x00000000
Reserved 0x00
Ack Type 0x00
Acknowledgement 0x00000000
Length 0x000000C8
Data Subpacket
Reserved 0x000018D8B4
Kind 0x0000
Length 0x000000B9
Method Call SMUID.Properties
Call Token 0xF8
Invoking UID SMUID (0xA8 | 0x00 0x00 0x00 0x00 0x00 0x00 0xF...
Method UID Properties (0xA8 | 0x00 0x00 0x00 0x00 0x00 0x00 0xFF 0...
Parameters [["MaxPacketSize" = 0x7EC, "MaxComPacketSize" = 0...
Start List Token 0xF0
List ["MaxPacketSize" = 0x7EC, "MaxComPacketSize" = 0x...
Start List Token 0xF0
Named Value "MaxPacketSize" = 0x7EC
Start Name Token 0xF2
Short Atom Token 0xAD | 0x4D 0x61 0x78 0x50 0x61 0x63 0x6B 0x65 0x74 ...
Short Atom Token 0x82 | 0x7EC
End Name Token 0xF3
Named Value "MaxComPacketSize" = 0x800
Start Name Token 0xF2
Medium Atom Token 0xD0 0x10 | 0x4D 0x61 0x78 0x43 0x6F 0x6D 0x50 0x61 ...
Short Atom Token 0x82 | 0x800
End Name Token 0xF3
Named Value "MaxResponseComPacketSize" = 0x800
Start Name Token 0xF2

Figure 6.16: NVMe Command with TCG Details

NVMe: Command IOPS and Doorbell Statistical Information

IOPS and Doorbell statistical information can be displayed from an NVMe Trace by selecting an NVMe Packet with a Read or Write Command and viewing the Metrics box. See Figure 6.17 and Figure 6.18 on page 142.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,
  (time from submission command to command completion

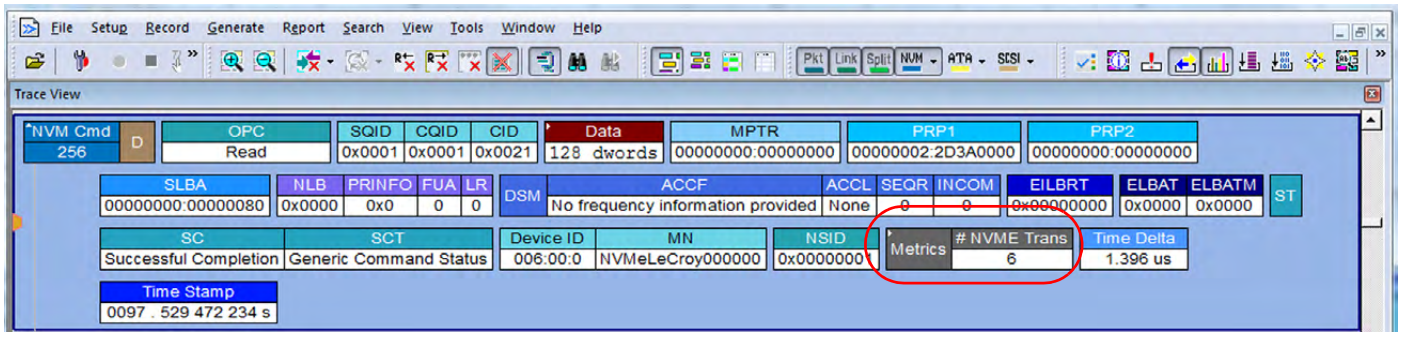


Figure 6.17: NVMe Read Command Packet with Metrics Box

Move the cursor over the Metrics box to display the information about the NVMe Command. See Figure 6.18.

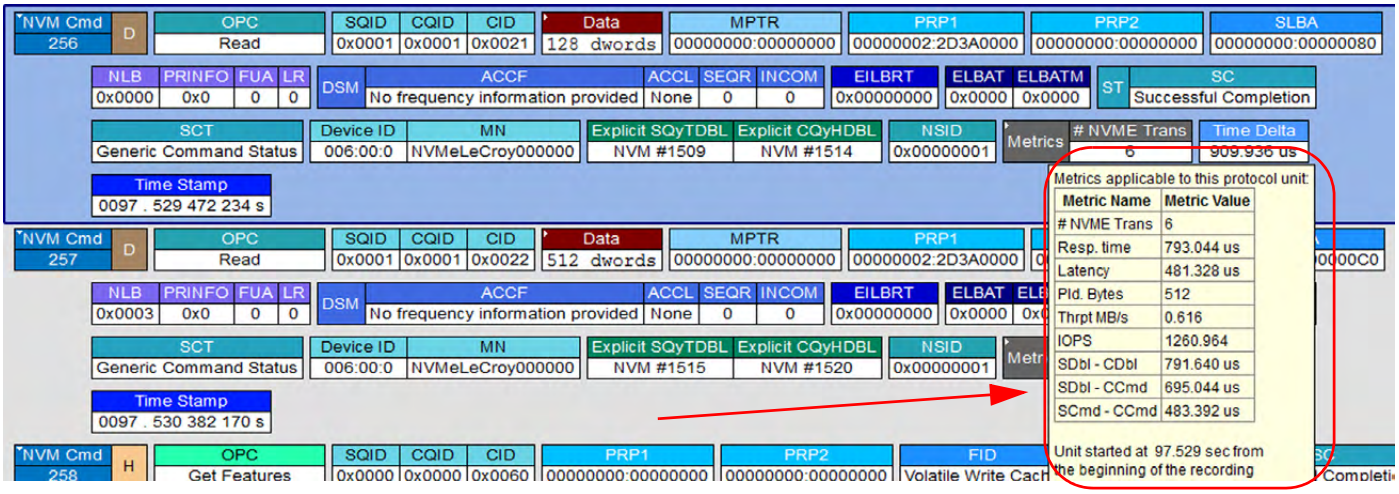

NVM Cmd 256 D
OPC Read
SQID 0x0001 CQID 0x0001 CID 0x0021
Data 128 dwords
MPTR 00000000:00000000
PRP1 00000002:2D3A0000
PRP2 00000000:00000000
SLBA 00000000:00000080
NLB 0x0000 PRINFO 0x0 FUA 0 LR 0
DSM No frequency information provided
ACCF ACCL 0 SEQR 0 INCOM 0
EILBRT 0x00000000
ELBAT 0x0000 ELBATM 0x0000
ST
SC Successful Completion
SCT Generic Command Status
Device ID 006:00:0 MN NVMeLeCroy000000
Explicit SQyTDBL NVM #1509
Explicit CQyHDBL NVM #1514
NSID 0x00000001
Metrics # NVME Trans 6 Time Delta 909.936 us
Time Stamp 0097 . 529 472 234 s
NVM Cmd 257 D
OPC Read
SQID 0x0001 CQID 0x0001 CID 0x0022
Data 512 dwords
MPTR 00000000:00000000
PRP1 00000002:2D3A0000
NLB 0x0003 PRINFO 0x0 FUA 0 LR 0
DSM No frequency information provided
ACCF ACCL 0 SEQR 0 INCOM 0
EILBRT 0x00000000
ELBAT 0x0000
SCT Generic Command Status
Device ID 006:00:0 MN NVMeLeCroy000000
Explicit SQyTDBL NVM #1515
Explicit CQyHDBL NVM #1520
NSID 0x00000001
Time Stamp 0097 . 530 382 170 s
Metrics applicable to this protocol unit:
Metric Name Metric Value
NVME Trans 6
Resp. time 793.044 us
Latency 481.328 us
Pld. Bytes 512
Thrpt MB/s 0.616
IOPS 1260.964
SDbl - CDbl 791.640 us
SDbl - CCmd 695.044 us
SCmd - CCmd 483.392 us
Unit started at 97.529 sec from the beginning of the recording
NVM Cmd 258 H
OPC Get Features
SQID 0x0000 CQID 0x0000 CID 0x0060
PRP1 00000000:00000000
PRP2 00000000:00000000
FID

Figure 6.18: NVMe Read Command Packet with Metrics Displayed

If you click on the white arrow in the Metrics box, the information about the packet will be displayed in the Trace. See Figure 6.19.

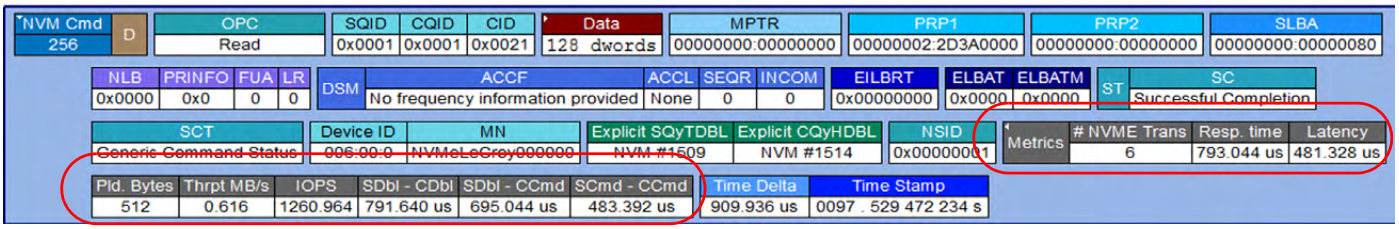

NVM Cmd 256 D
OPC Read
SQID 0x0001 CQID 0x0001 CID 0x0021
Data 128 dwords
MPTR 00000000:00000000
PRP1 00000002:2D3A0000
PRP2 00000000:00000000
SLBA 00000000:00000080
NLB 0x0000 PRINFO 0x0 FUA 0 LR 0
DSM No frequency information provided
ACCF ACCL 0 SEQR 0 INCOM 0
EILBRT 0x00000000
ELBAT 0x0000 ELBATM 0x0000
ST
SC Successful Completion
SCT Generic Command Status
Device ID 006:00:0 MN NVMeLeCroy000000
Explicit SQyTDBL NVM #1509
Explicit CQyHDBL NVM #1514
NSID 0x00000001
Metrics # NVME Trans 6 Resp. time 793.044 us Latency 481.328 us
Pld. Bytes 512
Thrpt MB/s 0.616
IOPS 1260.964
SDbl - CDbl 791.640 us
SDbl - CCmd 695.044 us
SCmd - CCmd 483.392 us
Time Delta 909.936 us
Time Stamp 0097 . 529 472 234 s

Figure 6.19: NVMe Read Command Packet with Metrics Displayed in Trace

The IOPS value is defined when you move the cursor over the IOPS box. See Figure 6.20

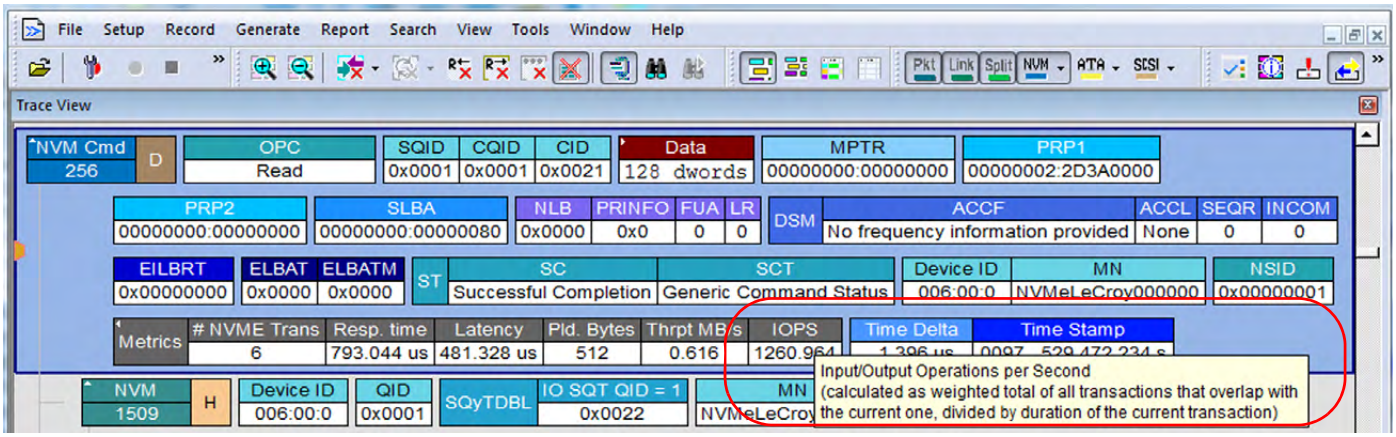

File Setup Record Generate Report Search View Tools Window Help
Trace View
NVM Cmd 256 D
OPC Read
SQID 0x0001 CQID 0x0001 CID 0x0021
Data 128 dwords
MPTR 00000000:00000000
PRP1 00000002:2D3A0000
PRP2 00000000:00000000
SLBA 00000000:00000080
NLB 0x0000 PRINFO 0x0 FUA 0 LR 0
DSM
ACCF No frequency information provided
ACCL None SEQR 0 INCOM 0
EILBRT 0x00000000 ELBAT 0x0000 ELBATM 0x0000
ST
SC Successful Completion
SCT Generic Command Status
Device ID 006:00:0
MN NVMeLeCroy000000
NSID 0x00000001
Metrics # NVME Trans 6 Resp. time 793.044 us Latency 481.328 us Pld. Bytes 512 Thrpt MB/s 0.616 IOPS 1260.964
Time Delta Time Stamp
Input/Output Operations per Second
(calculated as weighted total of all transactions that overlap with the current one, divided by duration of the current transaction)
NVM 1509 H
Device ID 006:00:0
QID 0x0001
SQyTDBL
IO SQT QID = 1 0x0022
MN NVMeLeCroy

Figure 6.20: NVMe READ Command: IOPS Defined

The NMV Command IOPS can be viewed in Bus Utilization mode by selecting the Bus Utilization icon in the toolbar and selecting the Graph areas icon. See Figure 6.21.

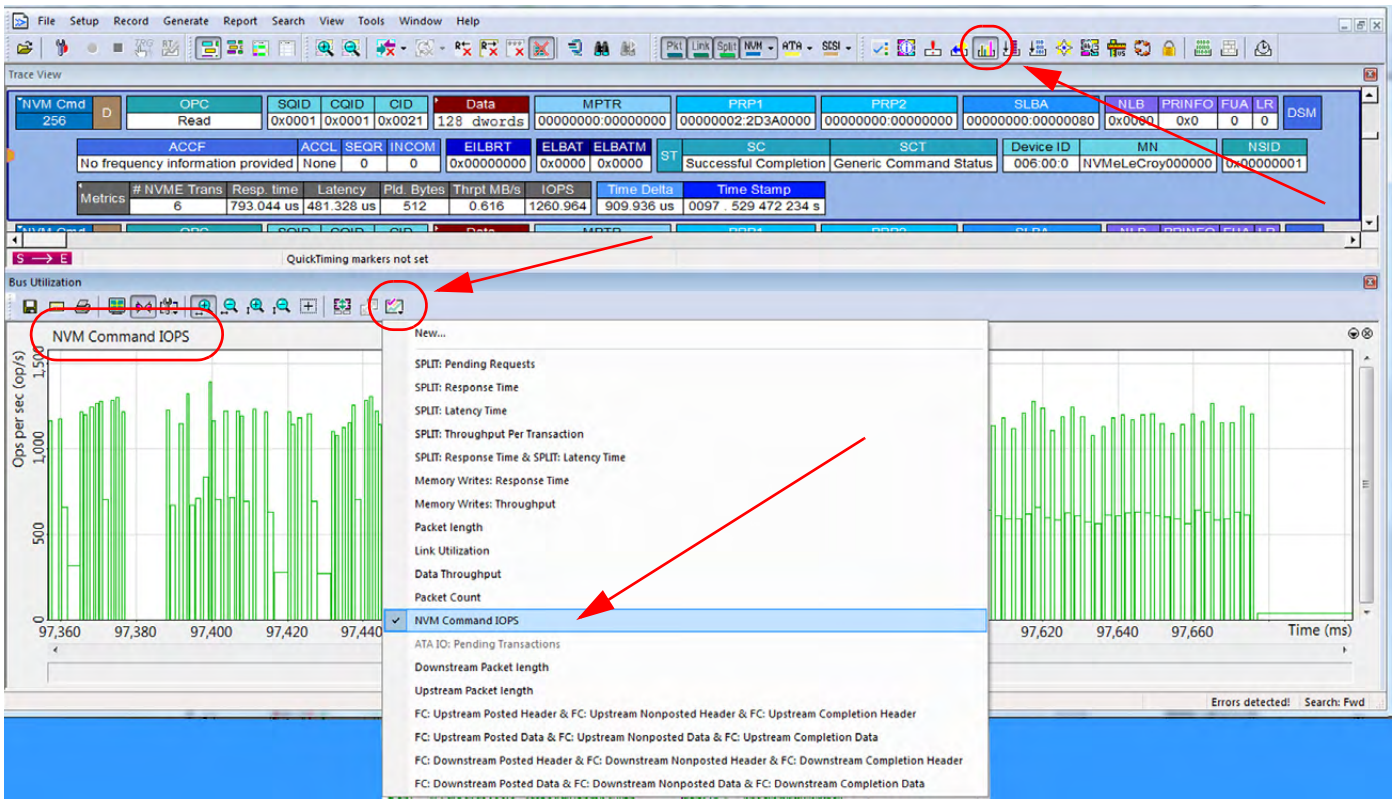


Figure 6.21: NVMe READ Command: Bus Utilization -- Graphs Areas Icon

NVMe Command IOPS can also be displayed in Spreadsheet and Detailed Views. See Figure 6.22.

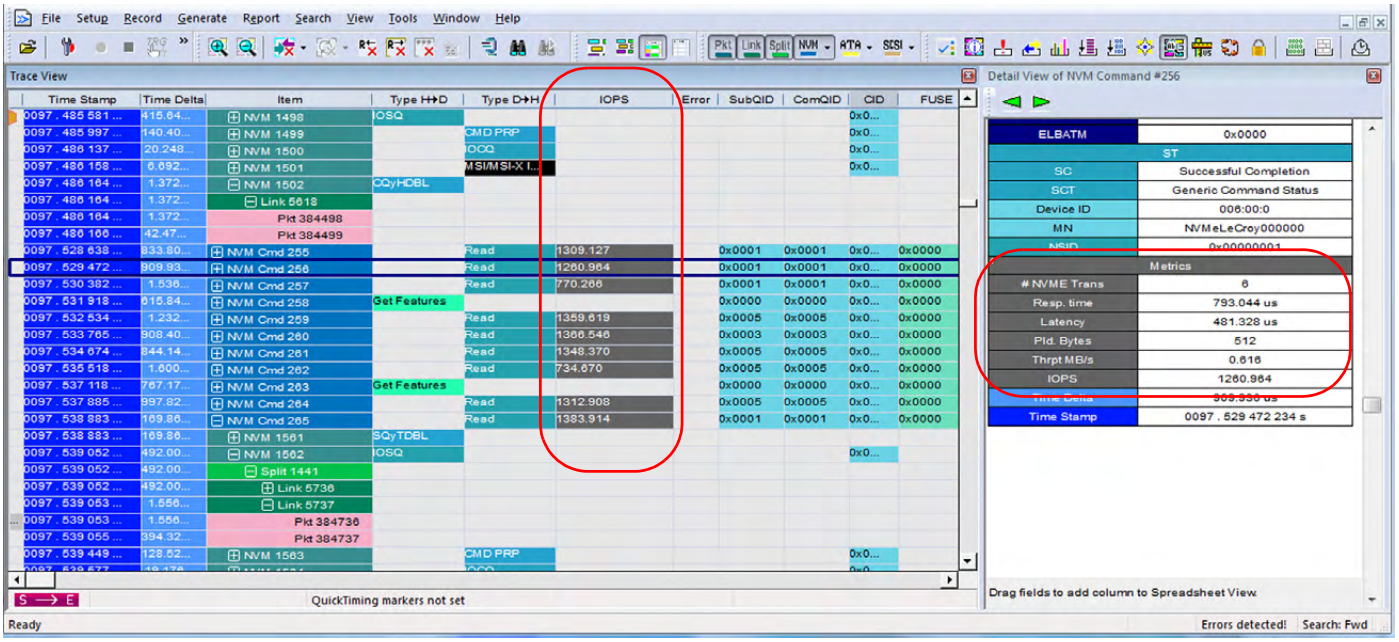

File Setup Record Generate Report Search View Tools Window Help
Trace View
Time Stamp | Time Delta | Item | Type H→D | Type D→H | IOPS | Error | SubQID | ComQID | CID | FUSE
Detail View of NVM Command #256
ELBATM 0x0000
ST
SC Successful Completion
SCT Generic Command Status
Device ID 006:00:0
MN NVMeLeCroy000000
Metrics
NVME Trans 6
Resp. time 793.044 us
Latency 481.328 us
Pld. Bytes 512
Thrpt MB/s 0.616
IOPS 1260.964
Time Stamp 0097 . 529 472 234 s
Drag fields to add column to Spreadsheet View
QuickTiming markers not set
Ready
Errors detected!
Search: Fwd

Figure 6.22: NVMe READ Command: IOPS Statistics

NVMe: Decode for Doorbells

Each type of doorbell's cell of an NVMe command is able to represent 1 of 4 states:

- Explicit (NVMe command contain concrete DBL). See Figure 6.23 on page 145.
- Implicit (Some doorbells implicitly complete previous commands. Such commands do not have a doorbell that can be associated one to one. This will be indicated in the trace.)
- Missing (NVMe cmd Is Incomplete, and DBL missing)
- Filtered (DBL is filtered out in Recording rules)

Tooltips:

- For SQyTDBL: Command was explicitly/implicitly initiated by SQyTDBL in NVMe #number (See Figure 6.23 on page 145)
- For CQyHDBL: Command was explicitly/implicitly finished by CQyHDBL in NVMe #number
- For Missing Doorbells: Doorbell is missing
- For Filtered: Doorbells are filtered out

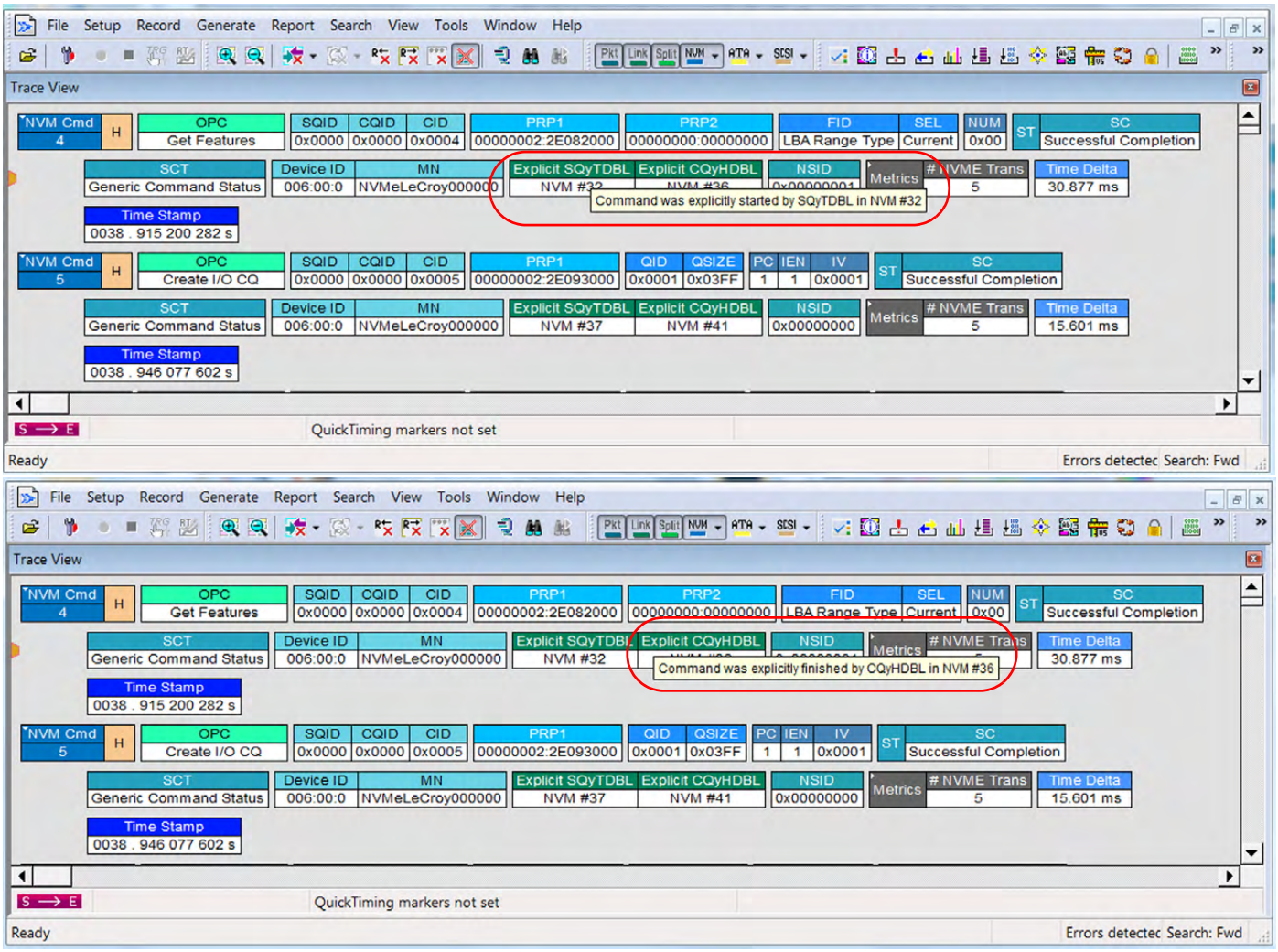
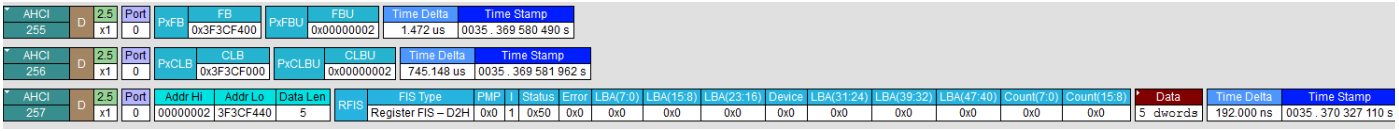


Figure 6.23: NVMe Decoding: Example of Explicit Doorbell in Trace with Tool Tips

6.13.5 AHCI

AHCI level decode displays AHCI transactions. PCIe Protocol Suite decodes the storage commands starting from lower Transaction Layer decodes. In the case of AHCI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the AHCI decode level.



AHCI	D	2.5	Port	PxFB	FB	PxFBU	FBU	Time Delta	Time Stamp
255		x1	0		0x3F3CF400		0x00000002	1.472 us	0035 . 369 580 490 s

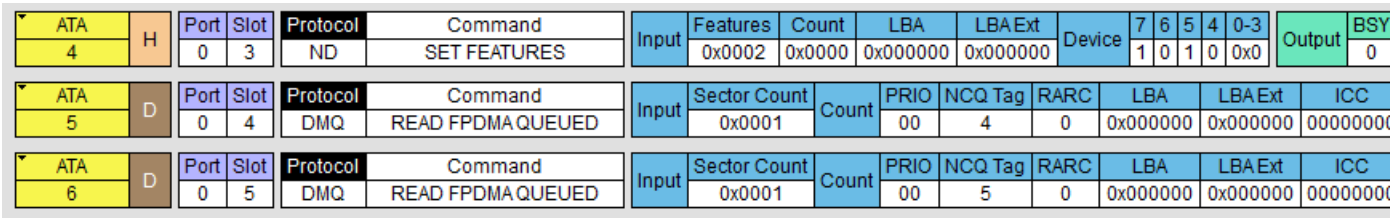
AHCI	D	2.5	Port	PxCLB	CLB	PxCLBU	CLBU	Time Delta	Time Stamp
256		x1	0		0x3F3CF000		0x00000002	745.148 us	0035 . 369 581 962 s

AHCI	D	2.5	Port	Addr Hi	Addr Lo	Data Len	RFIS	FIS Type	PMP	I	Status	Error	LBA(7:0)	LBA(15:8)	LBA(23:16)	Device	LBA(31:24)	LBA(39:32)	LBA(47:40)	Count(7:0)	Count(15:8)	Data	Time Delta	Time Stamp
257		x1	0	00000002	3F3CF440	5		Register FIS – D2H	0x0	1	0x50	0x0	0x0	0x0	0x0	0x0	0x0	0x0	0x0	0x0	0x0	5 dwords	192.000 ns	0035 . 370 327 110 s

Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and AHCI transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.13.6 ATA

ATA level decode displays SATA transactions. PCIe Protocol Suite decodes the storage commands starting from lower Transaction Layer decodes. In the case of ATA, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then AHCI level and finally the ATA decode level.


ATA 4 H | Port 0 | Slot 3 | Protocol ND | Command SET FEATURES | Input | Features 0x0002 | Count 0x0000 | LBA 0x000000 | LBA Ext 0x000000 | Device | 7 1 | 6 0 | 5 1 | 4 0 | 0-3 0x0 | Output | BSY 0
ATA 5 D | Port 0 | Slot 4 | Protocol DMQ | Command READ FPDMA QUEUED | Input | Sector Count 0x0001 | Count | PRIO 00 | NCQ Tag 4 | RARC 0 | LBA 0x000000 | LBA Ext 0x000000 | ICC 00000000
ATA 6 D | Port 0 | Slot 5 | Protocol DMQ | Command READ FPDMA QUEUED | Input | Sector Count 0x0001 | Count | PRIO 00 | NCQ Tag 5 | RARC 0 | LBA 0x000000 | LBA Ext 0x000000 | ICC 00000000

Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and ATA transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

ATA IO: Pending Transactions Statistical Report

ATA IO Pending Transactions statistical information can be displayed from an ATA Trace by selecting an ATA Packet and viewing the Metrics box. See Figure 6.24.

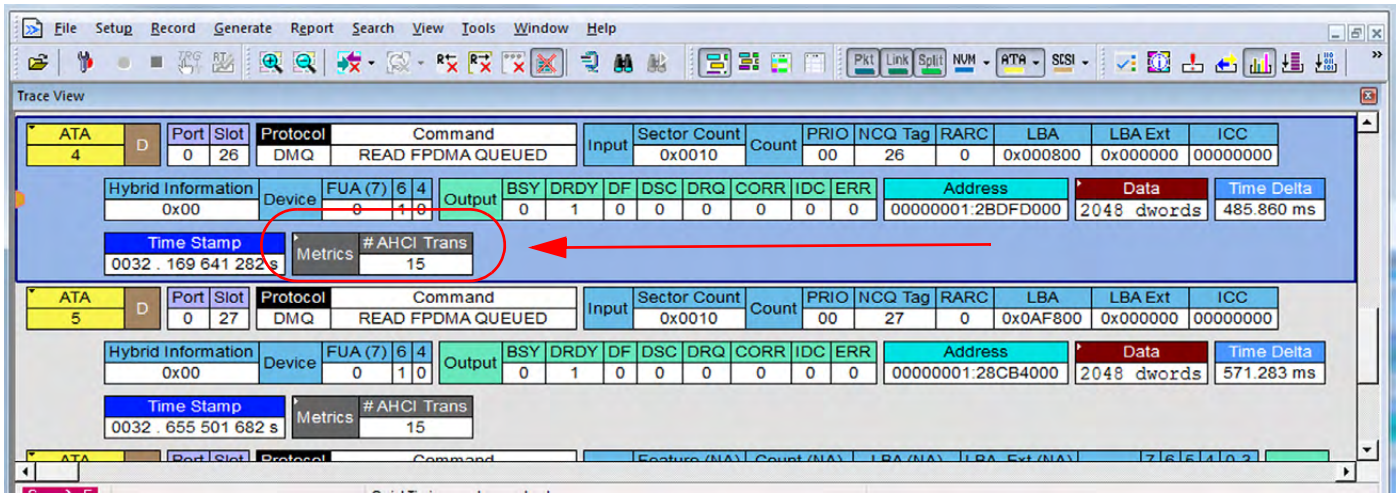

File Setup Record Generate Report Search View Tools Window Help
Trace View
ATA 4 D | Port 0 | Slot 26 | Protocol DMQ | Command READ FPDMA QUEUED | Input | Sector Count 0x0010 | Count | PRIO 00 | NCQ Tag 26 | RARC 0 | LBA 0x000800 | LBA Ext 0x000000 | ICC 00000000
Hybrid Information 0x00 | Device | FUA (7) 0 | 6 1 | 4 0 | Output | BSY 0 | DRDY 1 | DF 0 | DSC 0 | DRQ 0 | CORR 0 | IDC 0 | ERR 0 | Address 00000001:2BDFD000 | Data 2048 dwords | Time Delta 485.860 ms
Time Stamp 0032 . 169 641 282 s | Metrics | # AHCI Trans 15
ATA 5 D | Port 0 | Slot 27 | Protocol DMQ | Command READ FPDMA QUEUED | Input | Sector Count 0x0010 | Count | PRIO 00 | NCQ Tag 27 | RARC 0 | LBA 0x0AF800 | LBA Ext 0x000000 | ICC 00000000
Hybrid Information 0x00 | Device | FUA (7) 0 | 6 1 | 4 0 | Output | BSY 0 | DRDY 1 | DF 0 | DSC 0 | DRQ 0 | CORR 0 | IDC 0 | ERR 0 | Address 00000001:28CB4000 | Data 2048 dwords | Time Delta 571.283 ms
Time Stamp 0032 . 655 501 682 s | Metrics | # AHCI Trans 15

Figure 6.24: ATA IO Pending Transactions: Metrics Box

Move the cursor over the Metrics box to display the information about the ATA Packet. See Figure 6.25 on page 148.

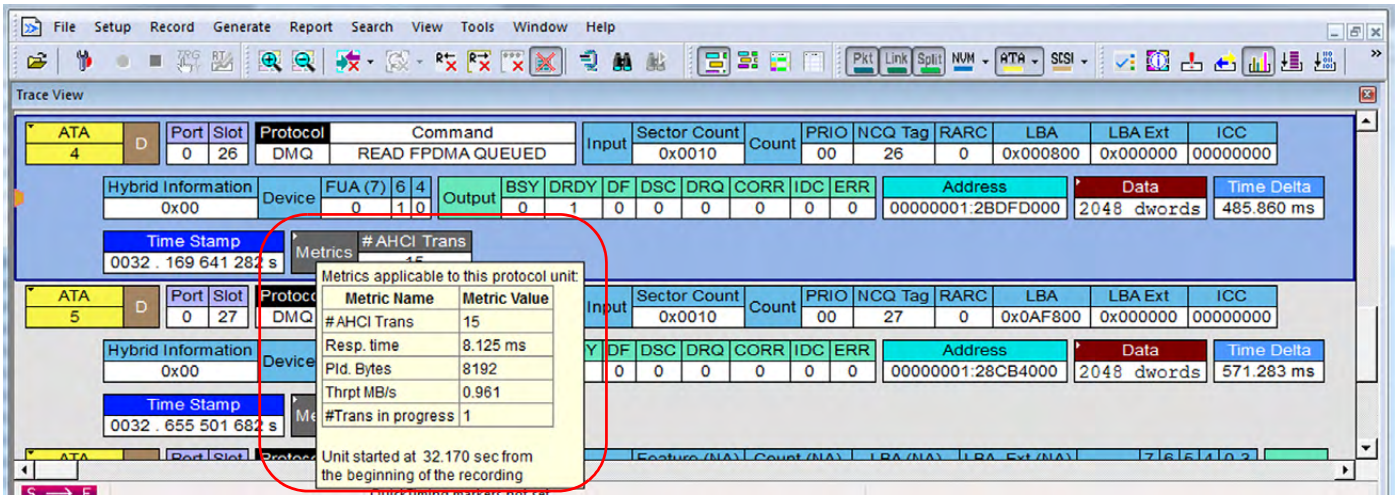

File Setup Record Generate Report Search View Tools Window Help
Trace View
ATA 4 D Port 0 Slot 26 Protocol DMQ Command READ FPDMA QUEUED Input Sector Count 0x0010 Count PRIO 00 NCQ Tag 26 RARC 0 LBA 0x000800 LBA Ext 0x000000 ICC 00000000
Hybrid Information 0x00 Device FUA (7) 0 6 1 4 0 Output BSY 0 DRDY 1 DF 0 DSC 0 DRQ 0 CORR 0 IDC 0 ERR 0 Address 00000001:2BDFD000 Data 2048 dwords Time Delta 485.860 ms
Time Stamp 0032 . 169 641 282 s Metrics # AHCI Trans
Metrics applicable to this protocol unit:
Metric Name Metric Value
AHCI Trans 15
Resp. time 8.125 ms
Pld. Bytes 8192
Thrpt MB/s 0.961
#Trans in progress 1
Unit started at 32.170 sec from the beginning of the recording
ATA 5 D Port 0 Slot 27 Input Sector Count 0x0010 Count PRIO 00 NCQ Tag 27 RARC 0 LBA 0x0AF800 LBA Ext 0x000000 ICC 00000000
Hybrid Information 0x00 Address 00000001:28CB4000 Data 2048 dwords Time Delta 571.283 ms
Time Stamp 0032 . 655 501 682 s

Figure 6.25: ATA IO Pending Transactions: Metrics Box -- Information Displayed

You can click on the small white arrow in the Metrics box to display the information in the Trace. See Figure 6.26.

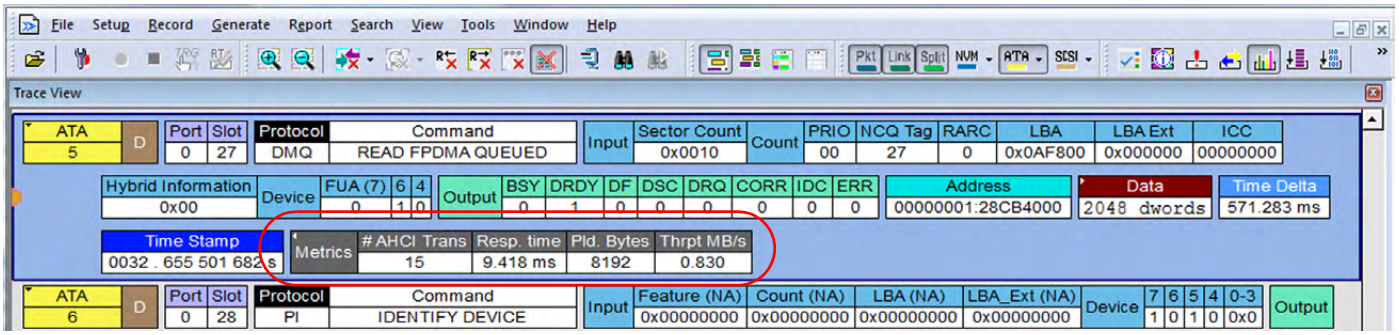

File Setup Record Generate Report Search View Tools Window Help
Trace View
ATA 5 D Port 0 Slot 27 Protocol DMQ Command READ FPDMA QUEUED Input Sector Count 0x0010 Count PRIO 00 NCQ Tag 27 RARC 0 LBA 0x0AF800 LBA Ext 0x000000 ICC 00000000
Hybrid Information 0x00 Device Output Address 00000001:28CB4000 Data 2048 dwords Time Delta 571.283 ms
Time Stamp 0032 . 655 501 682 s Metrics # AHCI Trans 15 Resp. time 9.418 ms Pld. Bytes 8192 Thrpt MB/s 0.830
ATA 6 D Port 0 Slot 28 Protocol PI Command IDENTIFY DEVICE Input Feature (NA) 0x00000000 Count (NA) 0x00000000 LBA (NA) 0x00000000 LBA_Ext (NA) 0x00000000 Device 7 6 5 4 0-3 1 0 1 0 0x0 Output

Figure 6.26: ATA IO Pending Transactions: Metrics Displayed in Trace

You can also view the ATA IO Pending Transactions by selecting the Bus Utilization icon in the toolbar and selecting the Graph Areas icon. See Figure 6.27 on page 149.

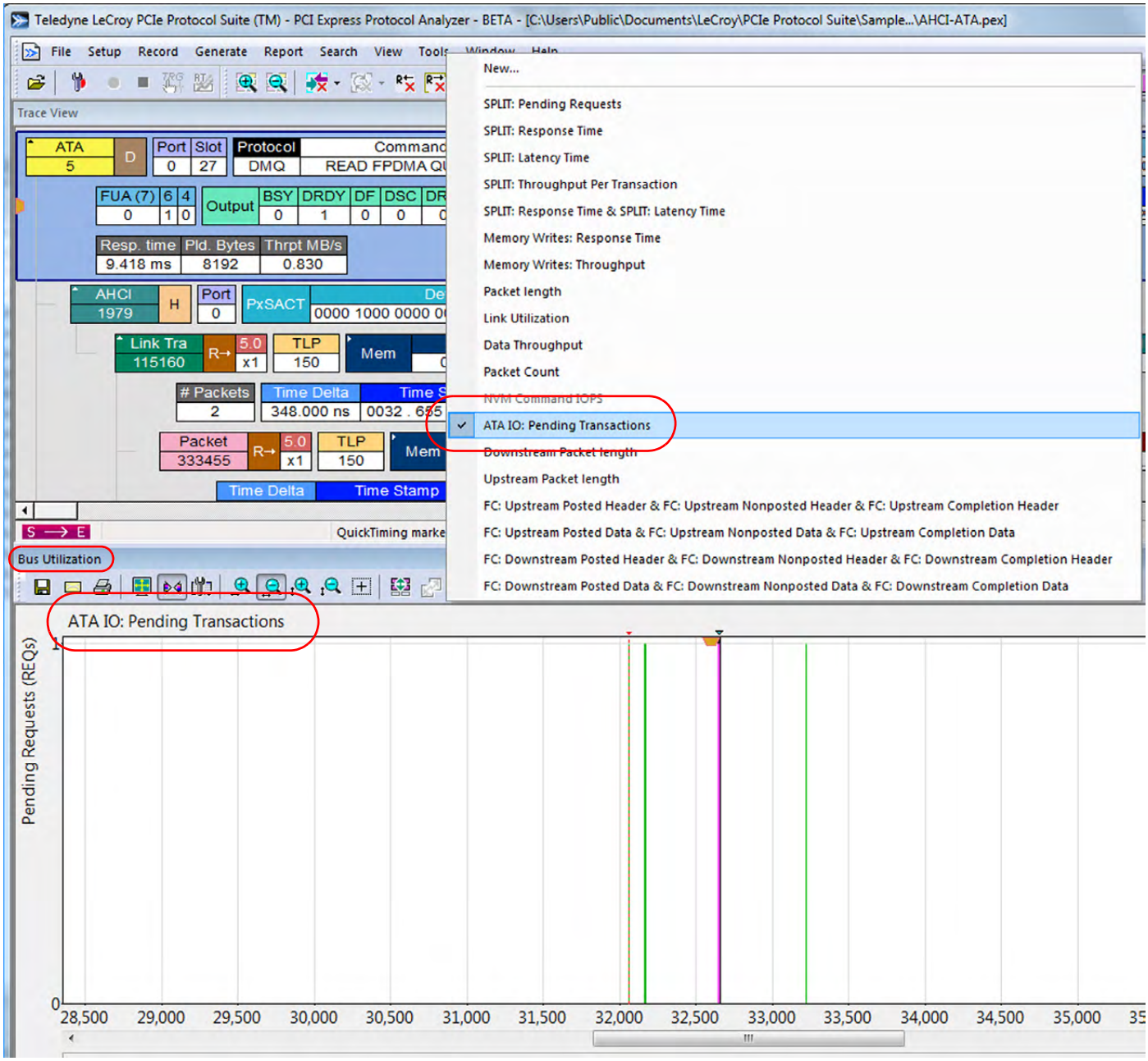
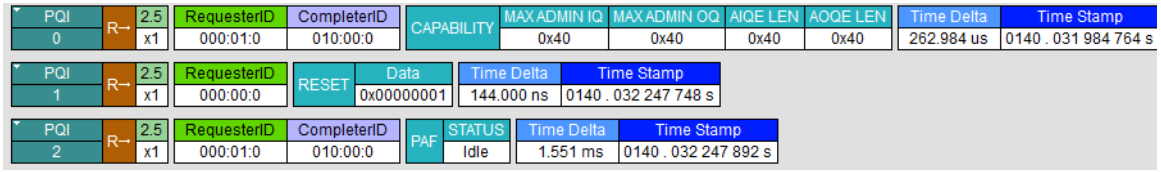

Teledyne LeCroy PCIe Protocol Suite (TM) - PCI Express Protocol Analyzer - BETA - [C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample...\AHCI-ATA.pex]
File Setup Record Generate Report Search View Tools Window Help
Trace View
New...
SPLIT: Pending Requests
SPLIT: Response Time
SPLIT: Latency Time
SPLIT: Throughput Per Transaction
SPLIT: Response Time & SPLIT: Latency Time
Memory Writes: Response Time
Memory Writes: Throughput
Packet length
Link Utilization
Data Throughput
Packet Count
NVM Command IOPS
ATA IO: Pending Transactions
Downstream Packet length
Upstream Packet length
FC: Upstream Posted Header & FC: Upstream Nonposted Header & FC: Upstream Completion Header
FC: Upstream Posted Data & FC: Upstream Nonposted Data & FC: Upstream Completion Data
FC: Downstream Posted Header & FC: Downstream Nonposted Header & FC: Downstream Completion Header
FC: Downstream Posted Data & FC: Downstream Nonposted Data & FC: Downstream Completion Data
Bus Utilization
ATA IO: Pending Transactions
Pending Requests (REQs)
28,500 29,000 29,500 30,000 30,500 31,000 31,500 32,000 32,500 33,000 33,500 34,000 34,500 35,000

Figure 6.27: ATA IO Pending Transactions: Bus Utilization View

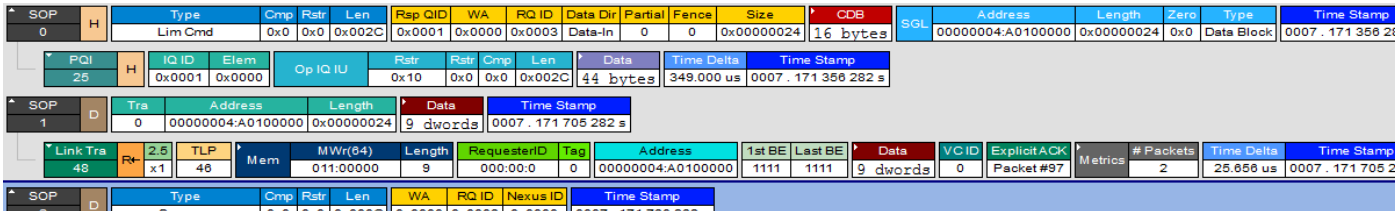
6.13.7 PQI

PQI level decode PQI displays PQI transactions. PCIe Protocol Suite decodes the storage commands starting from lower Transaction Layer decodes. In the case of PQI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the PQI decode level.


PQI 0 R→ 2.5 x1 RequesterID 000:01:0 CompleterID 010:00:0 CAPABILITY MAX ADMIN IQ 0x40 MAX ADMIN OQ 0x40 AIQE LEN 0x40 AOQE LEN 0x40 Time Delta 262.984 us Time Stamp 0140 . 031 984 764 s
PQI 1 R→ 2.5 x1 RequesterID 000:00:0 RESET Data 0x00000001 Time Delta 144.000 ns Time Stamp 0140 . 032 247 748 s
PQI 2 R→ 2.5 x1 RequesterID 000:01:0 CompleterID 010:00:0 PAF STATUS Idle Time Delta 1.551 ms Time Stamp 0140 . 032 247 892 s

6.13.8 SOP

SOP level decode SOP displays SOP transactions. PCIe Protocol Suite decodes the storage commands starting from lower Transaction Layer decodes. In the case of SOP, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SOP decode level.


SOP 0 H Type Lim Cmd Cmp Rstr Len 0x0 0x0 0x002C Rsp QID 0x0001 WA 0x0000 RQ ID 0x0003 Data Dir Data-In Partial 0 Fence 0 Size 0x00000024 CDB 16 bytes SGL Address 00000004:A0100000 Length 0x00000024 Zero 0x0 Type Data Block Time Stamp 0007 . 171 356 2
PQI 25 H IQ ID 0x0001 Elem 0x0000 Op IQ IU Rstr 0x10 Rstr 0x0 Cmp 0x0 Len 0x002C Data 44 bytes Time Delta 349.000 us Time Stamp 0007 . 171 356 282 s
SOP 1 D Tra 0 Address 00000004:A0100000 Length 0x00000024 Data 9 dwords Time Stamp 0007 . 171 705 282 s
Link Tra 48 R← 2.5 x1 TLP 46 Mem MWr(64) 011:00000 Length 9 RequesterID 000:00:0 Tag 0 Address 00000004:A0100000 1st BE 1111 Last BE 1111 Data 9 dwords VC ID 0 Explicit ACK Packet #97 Metrics # Packets 2 Time Delta 25.656 us Time Stamp 0007 . 171 705 2
SOP D Type Cmp Rstr Len WA RQ ID Nexus ID Time Stamp

Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SOP transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.13.9 SCSI

SCSI level decode SCSI displays SCSI transactions. PCIe Protocol Suite decodes the storage commands starting from lower Transaction Layer decodes. In the case of SCSI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SCSI decode level.

SCSI 0 SCSI CDB INQUIRY OpCode 0x12 Obsolete Not set EVPD Not set Page Code 0x0 AllocLen 36 CONTROL 0x00 INQUIRY Response LUN 0 Metrics # SOP IUs 3 Time Stamp 0007 . 171 356 282 s

The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SCSI transactions can be properly decoded. If the enumeration sequence is not available, the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

Chapter 7

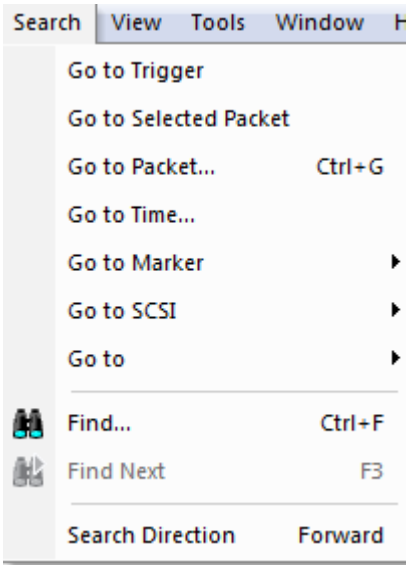
Searching CATC Traces

This chapter describes how to search for CATC Trace events.

7.1 CATC Trace Search Overview

Several search commands let you navigate a CATC Trace view to search for key events, such as errors and triggers.

To view the search options, click **Search** in the Menu bar.



7.2 Go to Trigger

To position a trigger packet at the top of the screen:

Select **Search > Go to Trigger**.

7.3 Go to Selected Packet

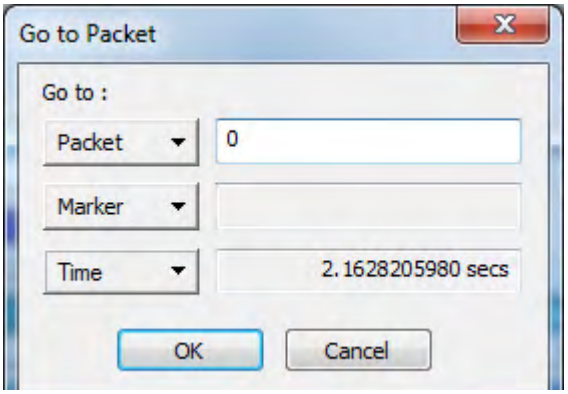
To position a selected packet at the top of the screen:

Select the packet and Select **Search > Go to Selected Packet**.

7.4 Go to Packet

To position a packet at the top of the screen:

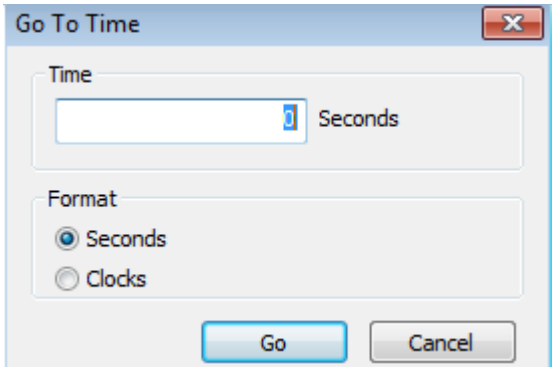
1. Select **Go to Packet** from the Search menu. A pop-up menu prompts you for the packet number, marker, or time.
2. Choose the needed transaction level from the Packet drop-down list and enter the transaction number. Please note that transaction levels is added to list if corresponding level is decoded for current trace file.
3. Click **OK**.



7.5 Go to Time

To position a specific time at the top of the screen:

1. Select **Go to Time** from the Search menu. A pop-up menu prompts you for the time in Seconds or Clocks.



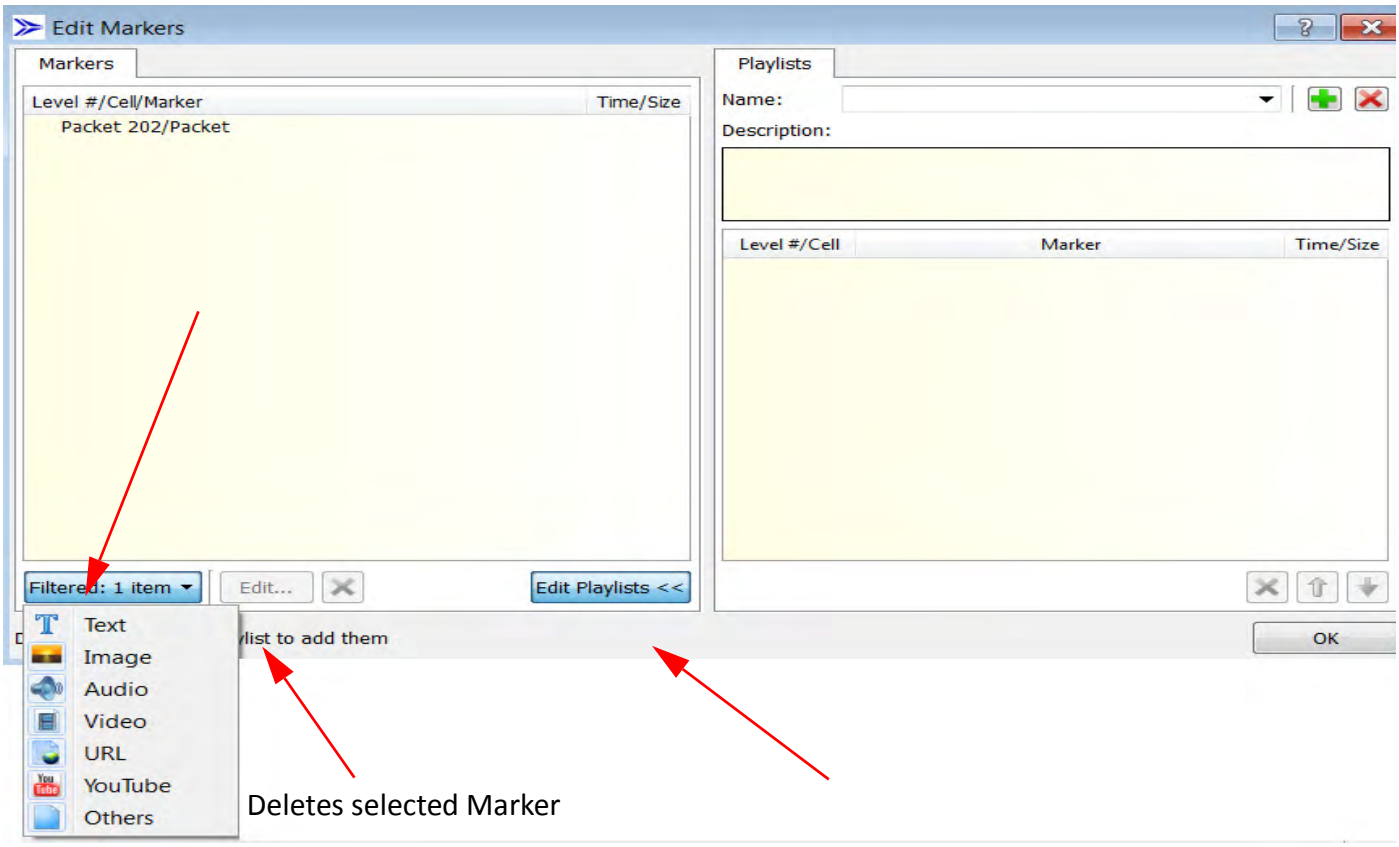
2. Enter the time and format (seconds or clocks).
3. Click **Go**.

7.6 Go To Marker

Use this operation to go directly to a specific or transaction packet that has been marked with a unique marker by the Set Marker operation.

To go to a marker:

1. Select **Go To Marker** from the Search Menu.
2. Select the marker you want from the fly-out menu.
   Alternatively, select **All Markers** to display the All Markers and Playlists dialog, then select a marker and click **Goto**.



The packet you want appears at the top of the screen. Marked packets have a red bar on the left edge.

7.6.1 Markers

This section explains the features of Markers. A marker is an entity that flags a physical or logical item of interest within a trace file. A marker contains one or more attachments. You can add a marker to a trace file or unmark a trace file by removing the marker.

Markers are represented graphically in a different way in the application.You can not only add markers to the packets but it is granular enabling you to also add markers to individual cells.

Markers Overview

This functionality provides the user an easy way to navigate through attachments which is a discrete piece of information or data added to a marker, for example, a text description

or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files.

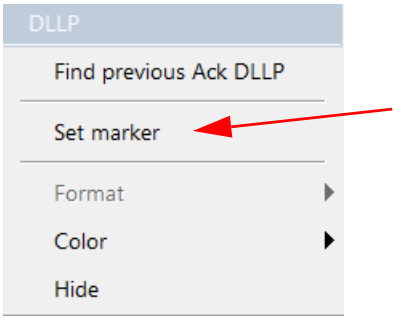
Functionality of Markers

The markers functionality allows you to add markers to:

- Whole packets or frames
- Specific Cells
- Specific values within a cell: Bytes, words, etc.

You can add attachments to markers.

Right-click on any cell of a packet and select **Set Marker** from the menu as shown below**.**



The Create Marker dialog displays (see Figure 7.28 on page 155).

Set New Marker

Markers are useful to identify specific points in the data. By default markers follow a numbering convention but can be renamed. Markers can also be inserted by using the keyboard (see Figure 7.28 on page 155):

- Hover your mouse pointer over a packet and press **Ctrl+K** to insert a marker for that packet.
- Click a packet to select it and press **Ctrl+L** to insert a marker for that packet.

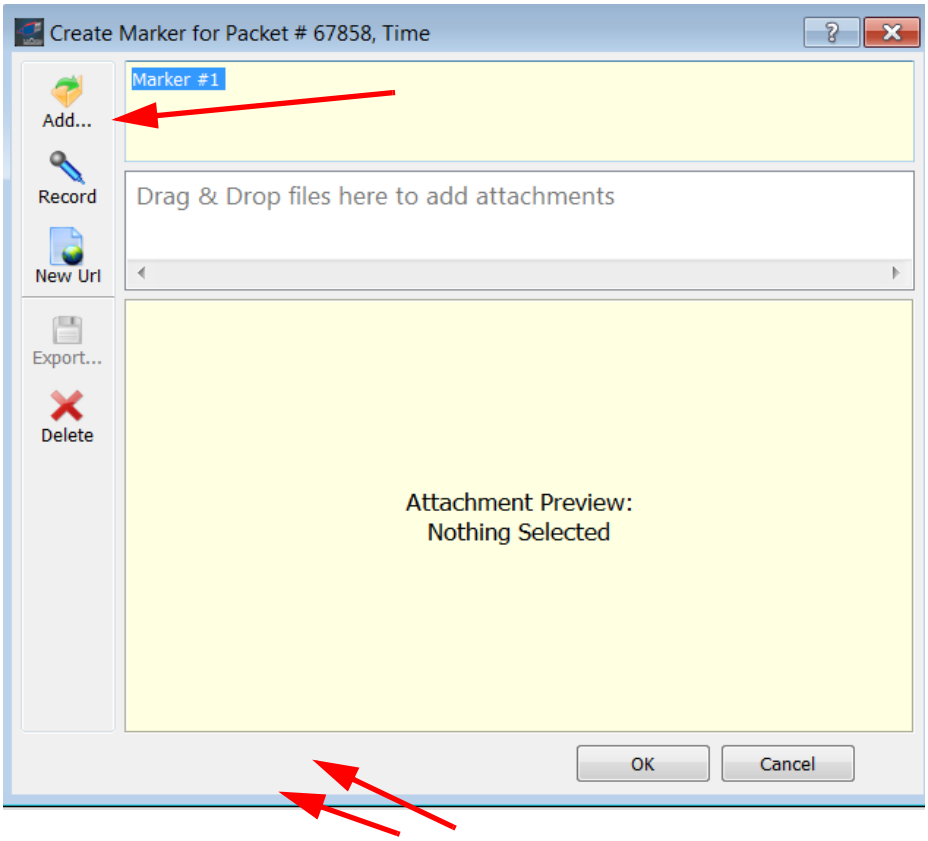


Figure 7.28: Create Marker for Packet Dialog

Click **Enter** to close the Marker dialog.

Click **ALT > Enter** to add a new line.

As shown above you can:

Add...	Add icon. Click on this icon to add any file. See "Adding an Attachment" on page 156.	Export...	Export icon. Click on this icon to export an attachment.
Record	Record icon. Click on this icon to record audio. See "Recording an Audio File" on page 157.	Delete	Delete icon. Click on this icon to delete an attachment
New Url	New URL icon. Click on this icon to add any URL.		

7.6.2 Attaching Markers

You can attach a discrete piece of information/data to a marker, for example, a text description or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files. You can also remove an attachment from a Marker.

7.6.3 Adding an Attachment

Perform the following steps to add an attachment to a marker:

1. Right-click on any cell in the trace and select **Set Marker.**
   The Create Marker window displays.
2. Click on the **Add** icon.
   The **Add File to the Marker** dialog displays.
3. Go to the file and select it to add it to the marker as an attachment.
4. Click **Open**.
   The file will appear in the Create Marker for Transfer... dialog as shown below. The Marker # appears in the top panel, the icons are displayed in the second panel and you can click on the icon on the third panel to view the file you are about to attach.
5. Click **OK** to add the attachments.

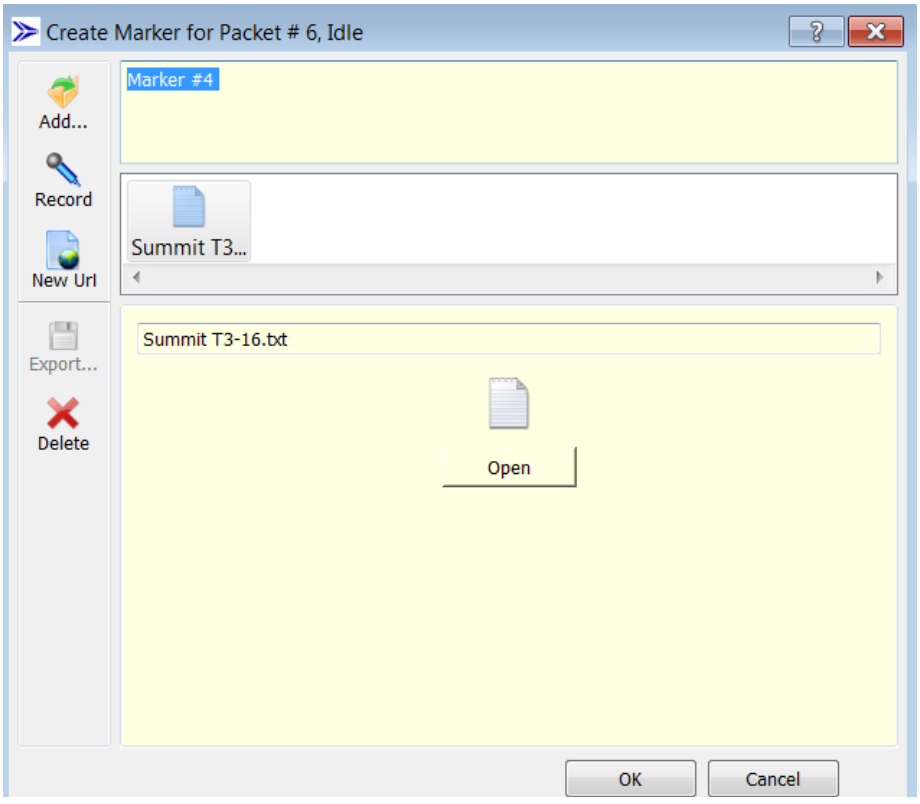


Figure 7.29: Create Marker for Packet Dialog

7.6.4 Recording an Audio File

The audio quality supports voice attachment and is not designed for high-quality audio Playback of audio content is not limited and depends on the formats supported by the installed playback engine.

Click the record icon and speak into the microphone to record an audio file.

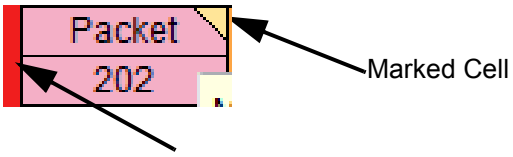
Note: This functionality is disabled if a microphone is not installed.

7.6.5 Video Files Supported

The user can attach video clips to the trace file (“add to the marker”). The playback of the Video clips is limited to the formats that are supported by the video codecs installed in the system.

7.6.6 Attachment Types and Visualization

The markers are represented graphically by a yellow triangle at the top right of the marked item and a red vertical bar at the left-most cell of a packet as shown below.



A marker may comprise any number of attachments of any types.

7.6.7 Embedded Attachments to a Marker

Embedded files are attached to the item marked and transported with the trace. You can embed the following types of files to a marker:

- Audio Files
- Video Files
- Image Files
- YouTube Files
- Web Pages
- Text Attachments
- Other Attachments

Attachments are embedded in the marker and saved in the trace file. Once attachments are placed in a marker, the marker can then be presented to a user in a story structured form. On opening the marker the window resembles the marker editing dialog.

Note: The use of Audio and Video markers is limited to the file types supported on a user’s system. CATC Walk has been tested with .mp3 and .wmv files, which are supported by Windows as installed. If additional codecs are installed, they should also work, but it is the user’s responsibility to choose formats that will work for whomever they intend to exchange CATC

trace files (no different than email attachments in this regard). Because of this dependency on installed codecs, there are situations where bugs in the codecs supplied by Microsoft or third-party applications can prevent proper operation of the Teledyne LeCroy PCIe Protocol Suite application. See the Teledyne LeCroy PCIe Protocol Suite Application Read-Me file for more information if you have problems with application crashes, etc.

7.6.8 Viewing Attachments of a Marker

If you hover over the marked cell (yellow triangle at the top right of the marked item), refer to "Attachment Types and Visualization" on page 157, a window pops up displaying the contents of the marked cell as shown below.

While hovering over the marked cell, it can start playing the start of the audio or video file, but it will stop after a short time due to the Analyzer's host system timeout for Tooltips. You must click on it to open the audio or video attachment for further listening or viewing.

To view an attachment you can click on any of the icons in the attachment bar and or you can double-click on the icon itself to open the attachment.

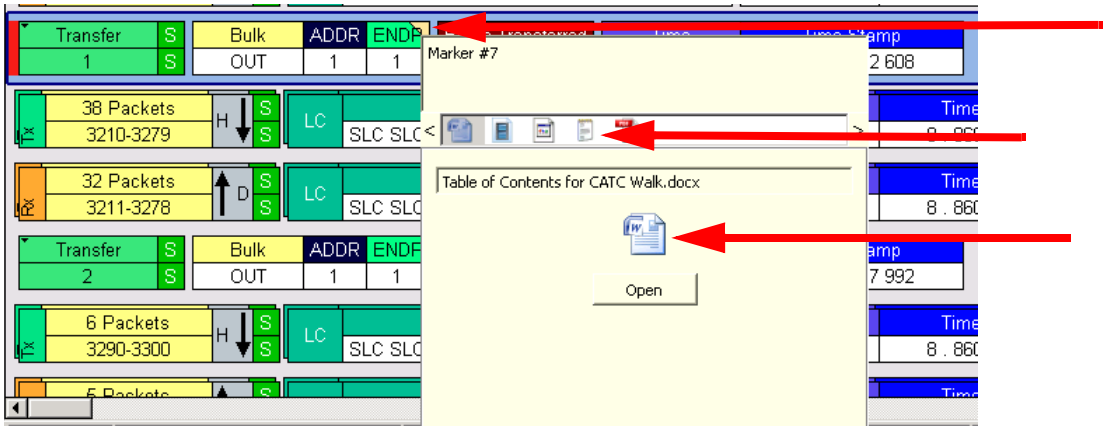


Figure 7.30: Pop-up Displaying Marker Contents

Text

The text attachment is displayed in the icon bar and in the main pop-up window. Text attachments are always shown at the top. The attachment file name is displayed in the field (see Figure 7.31 on page 159).

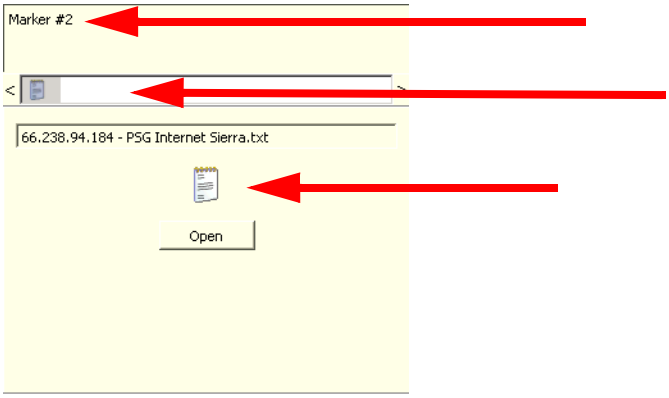


Figure 7.31: Text Attachment Pop-up Window

If there is no attachment, **No Attachments** displays in the status bar at the bottom.

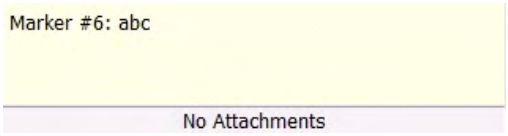


Figure 7.32: No Attachments Pop-up Window

If there are attachments, the status bar is hidden. You can move the cursor to an attachment icon in the list view and a preview of the attachment starts.

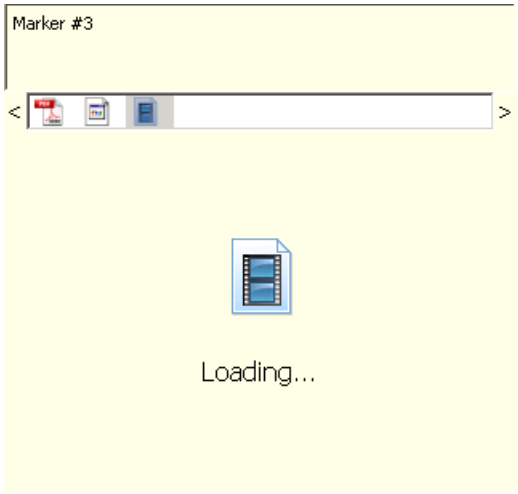
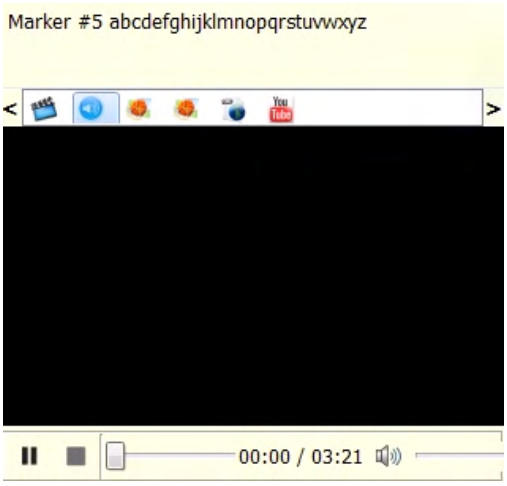


Figure 7.33: Preview Attachments Pop-up Window

Audio

Audio snippets that are recorded and attached to certain point of interest in a trace can be played. The basic Play, Start, Stop, Pause buttons are displayed to listen to the audio file.



Video

Video clips that are recorded and attached to certain point of interest in a trace can be played. The video is embedded in the tooltip with simple playback controls.

File Attachment

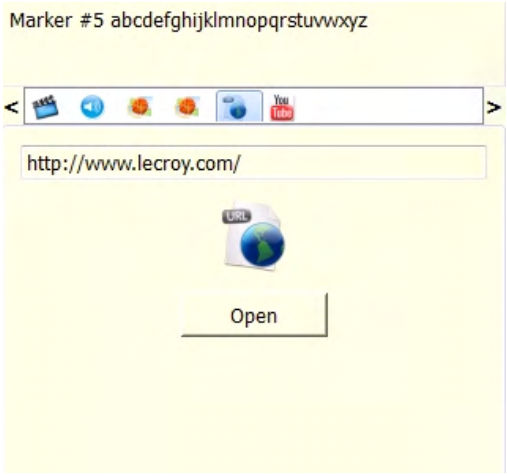
You can attach any kind of file, including images, PDFs, documents, media files, etc.

URL Link

You can specify a URL that links to a web page (i.e., YouTube), a network location, or a local file-system location.

Web Link

Due to the small size, the web page is not embedded in the callout. You can use the **Open** button to open the web link in the default web browser.



YouTube Video

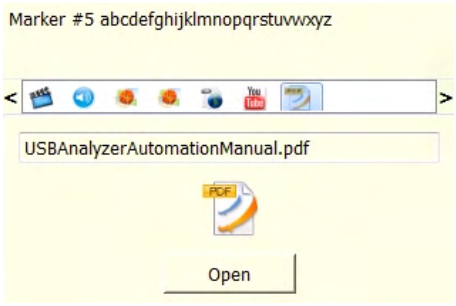
YouTube's video player is embedded for YouTube Video playback.

Images

The image is embedded in the trace.

Other Attachments

Click the **Open** button to open the attachment file with the system's default application for that file type.



7.6.9 Edit Marker

To edit a marker, right-click on the marked item and select **Edit marker** from the menu or **Ctrl + L**. The Edit Marker dialog displays (see Figure 7.34 on page 163). This Edit Marker window can be used to edit one marker at a time.

You can do the following in the Edit Marker dialog:

- Edit text attachment.
- Record audio attachment.
- Add URL link attachment
- Add a file attachment. Click on **File** and click the **Open** button or drag and drop the file.
- Preview audio/video/image/URL/YouTube attachment or open other files with system default application.
- Save an attachment to a file.
- Remove attachment.

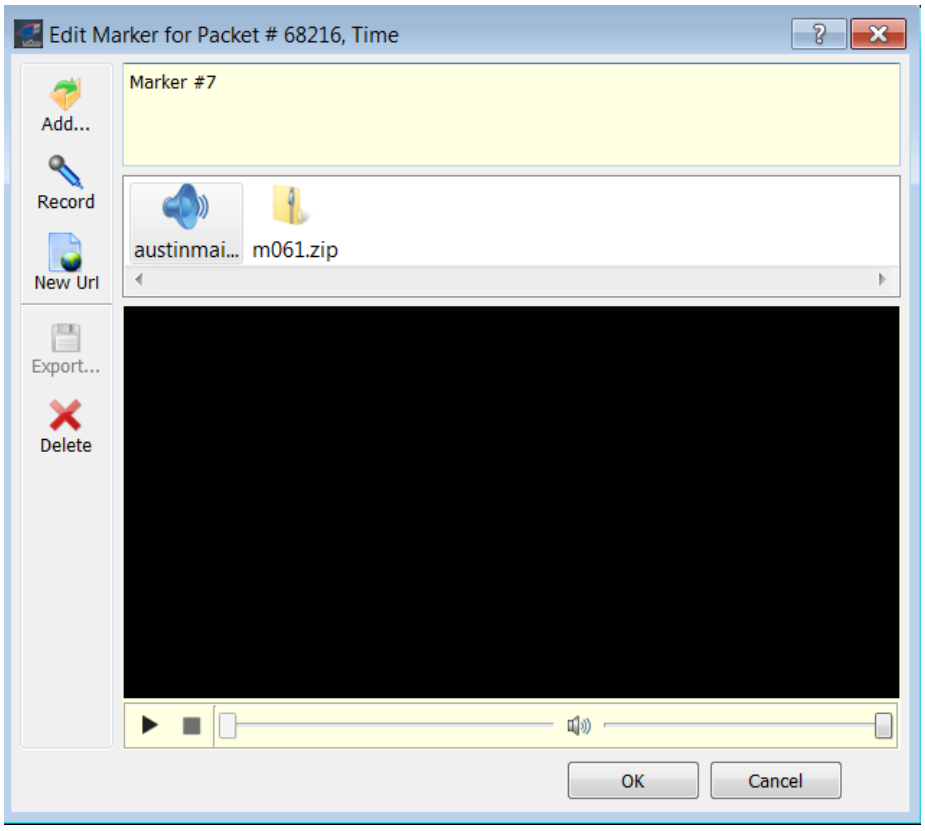


Figure 7.34: EDIT Marker for Packet Dialog

7.6.10 All Markers Window

Select **Search > Go to Marker > All Markers** or press **Ctrl + M** to display a list of all the markers in the file (see Figure 7.35 on page 164). The window uses a tree structure to show packets, fields and markers. The features of the Markers window are:

- All Markers are displayed.
- All attachments within the marker are displayed. Hovering over the marker displays a tool-tip displaying the size of all the attachments.
- You can collapse or expand the item marked to view the attachments.
- The Time and size of audio and video files are displayed.
- You can edit Playlists from this window.
- You can edit, delete a marker or delete all markers from this location.
- You can filter attachments within the marker.
- You can select a range of markers by clicking **Shift** and selecting a range.
- You can select multiple markers by clicking **Ctrl** and selecting individual markers.
- Double-click on a marker to go to that marker in the trace and close the dialog.

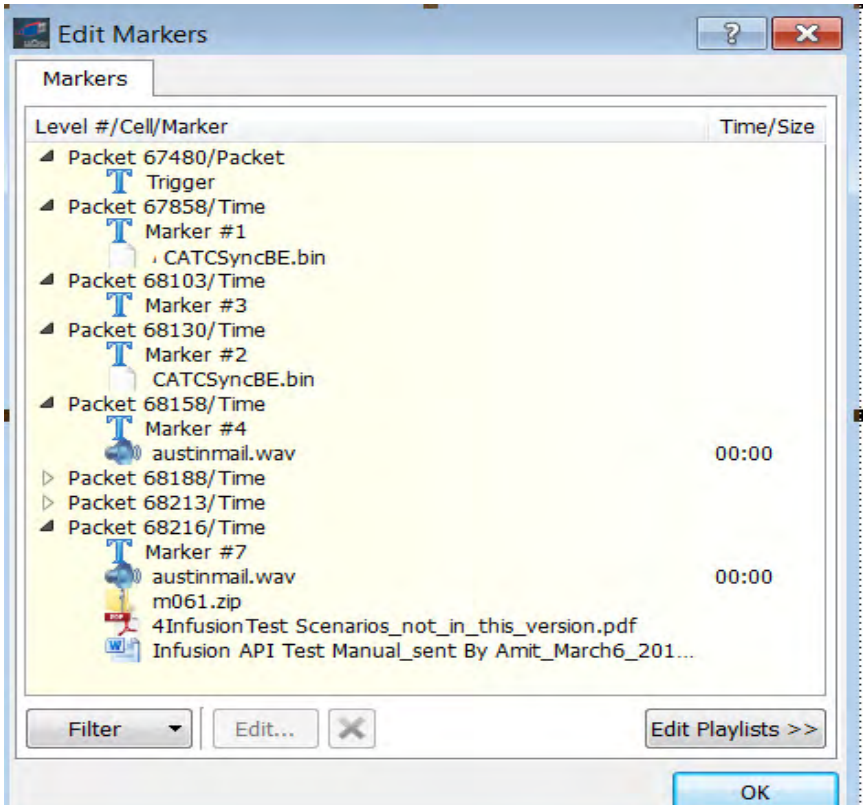


Figure 7.35: All Markers and Playlists Dialog

You can filter to show or hide text, image, audio, video, URL, YouTube videos and other files.

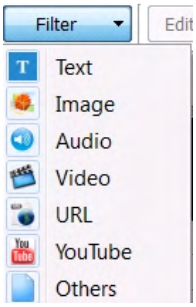


Figure 7.36: Filter Dialog

Clicking delete on markers to delete markers with attachments displays the Delete Marker(s) dialog. Checking the “Don’t ask again” checkbox will not display this confirmation dialog again.

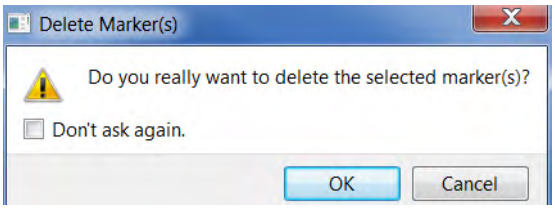


Figure 7.37: Confirmation Dialog

7.7 CATC Walk Playlist

This feature allows users to configure sequences of attachments into playlists. Any arbitrary order of attachments are allowed, and there are no limits on the number of playlists supported. This feature can be used for collaborating among developers as well for training, support and marketing purposes.

To access a playlist click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Manage Playlists** as shown below.

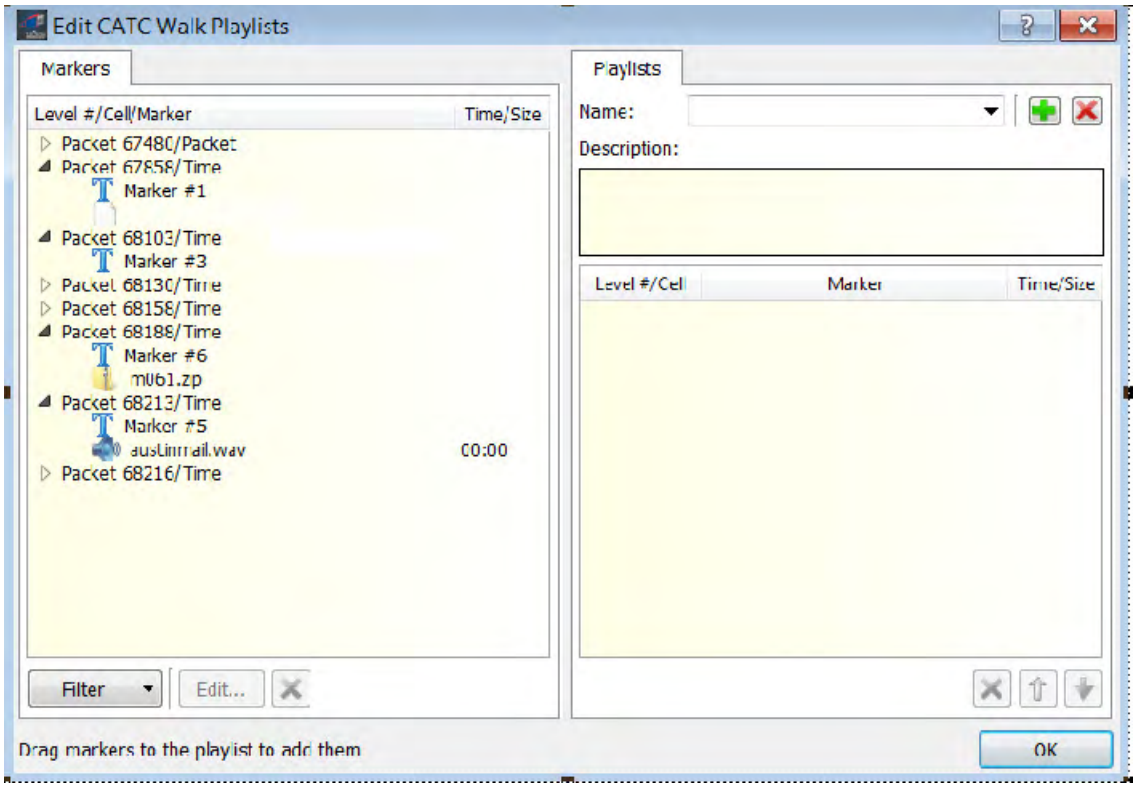


Figure 7.38: Edit CATC Walk Playlists Dialog

7.7.1 Playlist Functionality

You can do the following to manage playlists:

- Remove or edit current playlists
- Edit the playlist name
- Edit the playlist description
- List the sequence of attachments in current playlist
- List of all available attachments and drag/drop to a playlist.

As shown in the previous figure the Playlist window lists the markers with their attachments on the left and the playlist on the right (see Figure 7.38 on page 165).

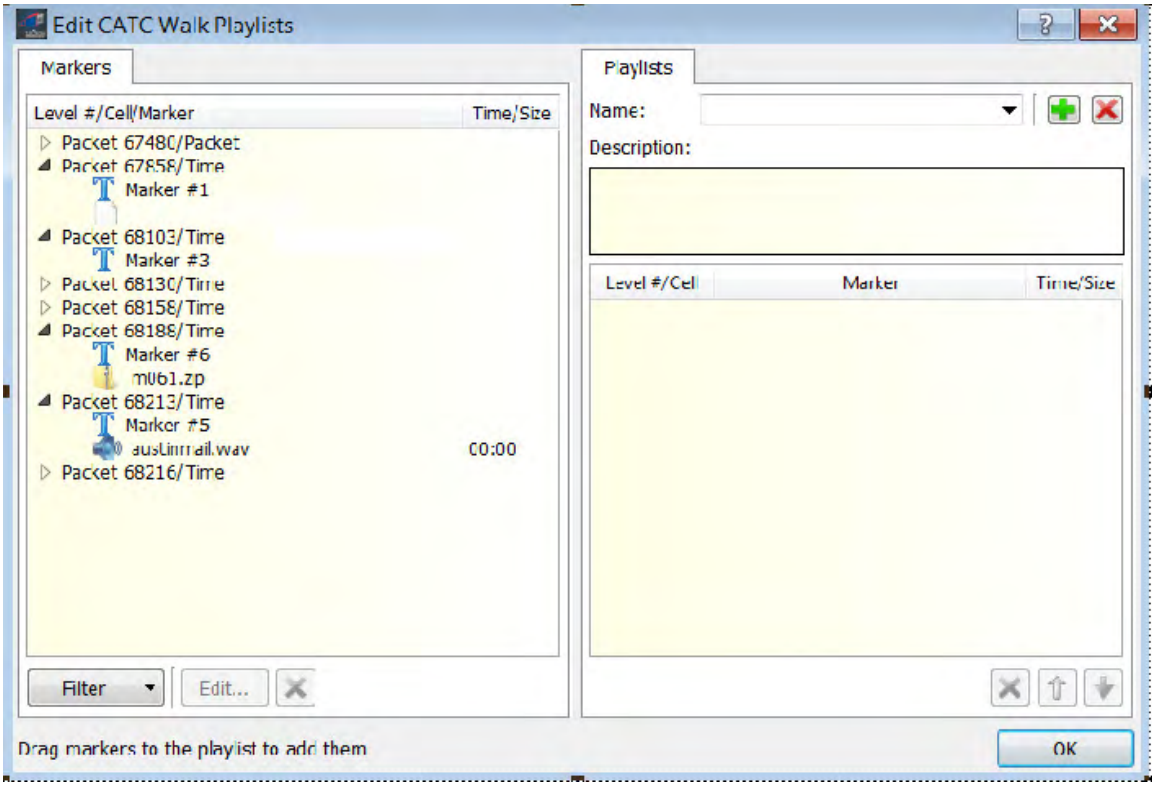


Figure 7.39: Edit CATC Walk Playlists Dialog

You can drag and drop and item or attachment from the **Marker** panel into the **Playlist** panel and build a story. Give a description of the playlist in the **Description** field and you can give a name to the playlist in the **Name** field.

You can add a new playlist by clicking on the green plus sign (+) on the right top corner of the Playlist panel, or delete a playlist by clicking the red (**x**) button.

If you have more than one playlist saved click on the Name drop-down arrow to select it. The drop-down menu lists all the available playlists

7.7.2 Playback Window

To playback a playlist, click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Play > Playlist 1** as shown below.

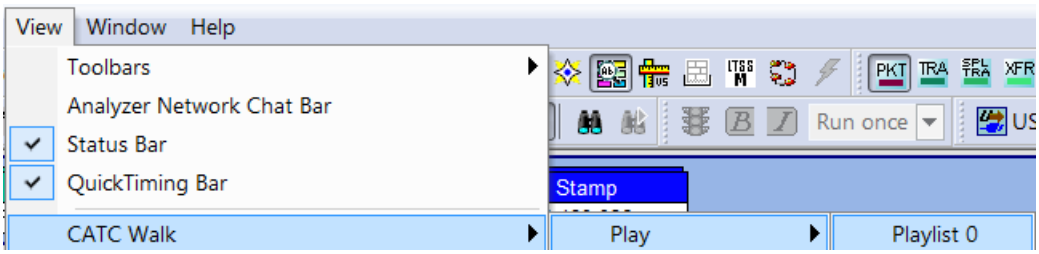


Figure 7.40: View Dialog

The attachment item starts to play in the playback window as shown below.

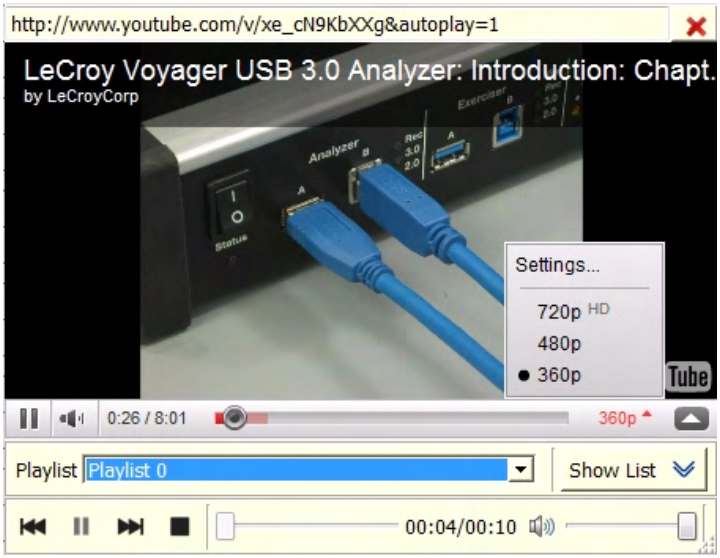


Figure 7.41: Playback Window

The playback window is resizable. The close button at the top right corner and the size grip for resizing at the bottom right corner will hide automatically when moving the cursor out of the window.

Users can provide commentary to a captured trace, converting it into a script or a story and can transfer this meta-information to others. Playlist Playback Controls.

Playlist Playback Controls

The playlist playback control buttons are:

- Play/Pause
- Stop
- Jump to Next attachment
- Jump to Previous attachment
- Seek slider for seeking to positions in media streams
- Volume slider
- Playback speed slider (for text attachments)

As a playlist is played back, the playback window is displayed in close proximity to the marked area, just like a regular tooltip window (see Figure 7.42 on page 168).

As the playback progresses, the view jumps to the element corresponding to the current attachment being played and the marked element is highlighted. During playback the user is prevented from interacting with the trace. To reinforce this restriction, the trace view is grayed-out visually, and only the packet with the item corresponding to the current attachment is colorized.

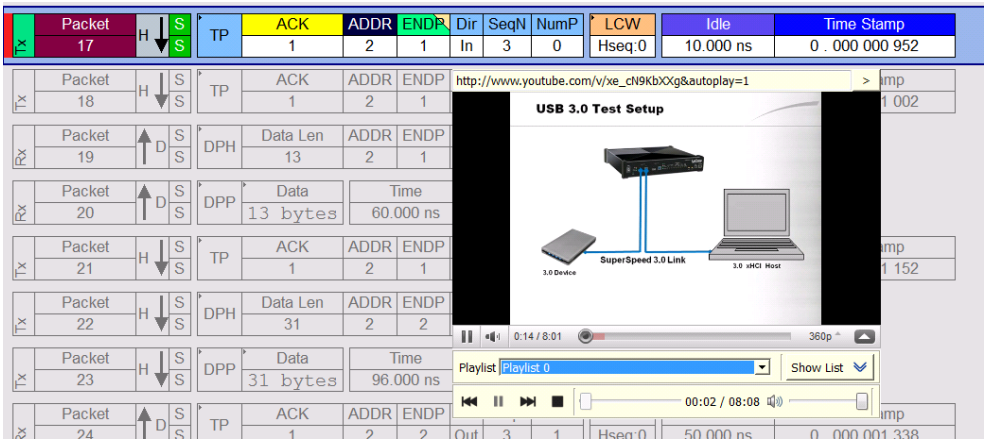


Figure 7.42: Playlist Playback View

7.8 Go To SCSI Menu

The **Go To SCSI** menu in the Search menu provides a quick way to search for a packet based on a SCSI commands and sub-commands. You can search for the following types of events:

- ❑ SCSI Operation
- ❑ Command Status
- ❑ Task Management
- ❑ Task Management Response
- ❑ Error
- ❑ SCSI Logical Unit Number

7.9 Go To Menu

The **Go To menu** in the Search menu provides a quick way to search for a packet based on a simple condition. You can search for the following types of events:

- ❑ TLP Type
- ❑ DLLP Type
- ❑ Ordered Set
- ❑ Link Event
- ❑ OBFF Message
- ❑ Traffic Class
- ❑ DLLP Virtual Channel
- ❑ TLP Virtual Channel
- ❑ Direction
- ❑ Speed
- ❑ Link Width
- ❑ Requester ID
- ❑ Completer ID
- ❑ Data Lengths
- ❑ Errors

7.10 Search Direction

Search direction can be toggled back and forth by using the command under the Search menu. Search Direction controls the direction of the search. Each time Search Direction is selected, the search order is reversed. For example, if the previous search was **forward**, choosing **Search Direction** toggles the current search to **backward**.

To verify the direction of a search look at the lower right corner of the screen. **Search: Bwd** or **Search: Fwd** should appear. If a direction is not indicated, it means that the status bar is turned off.

To turn on the Status bar, select from the menu **View > Status Bar**.

Keyboard shortcuts can also be used to control search direction:

- **Alt-f** means Search Forward.
- **Alt-b** means Search Backward.

7.11 Find

Find allows you to conduct complex searches in a CATC Trace. You can search by protocol level (Packets, Link Transactions, Split Transactions).

You can search packets by Event Group: TLP Type, TLP Header, TLP Prefix, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/ NAK Seq Number, Ordered Sets, Link Event, OBFF Code, Direction, Errors, TS1 Data, TS2 Data.

You can search link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag.

You can search split transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can seach NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP.

You can search PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can search AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, AHCI Raw Address AHCI Direction and, AHCI Errors.

You can search ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA port Multiplier Port, ATA Interruption Reason, ATA Error Type ATA Input/Output, ATA Payload Portion, ATA CFIS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields.

You can search SOP transactions by Event Group: SOP Information Unit ID, SOP Errors.

You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers.

The options Union, Intersection, and Exclusion allow you to create complex searches such as “Find x OR y” or “Exclude all x or y.”

To find an item:

1. Open a CATC Trace.
2. Open Find by selecting **Search > Find** from the menu or clicking (see Figure 7.43 on page 170).

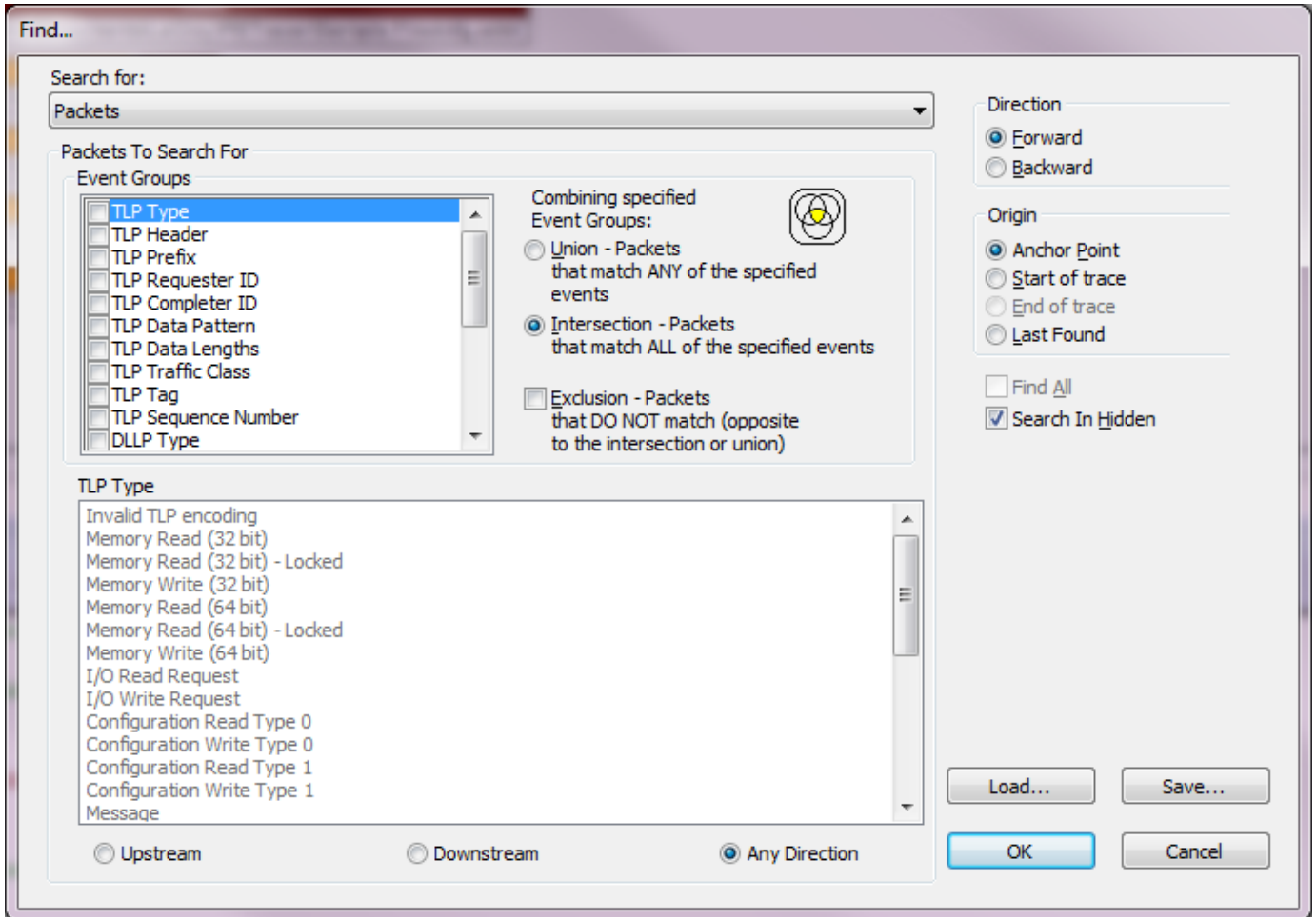
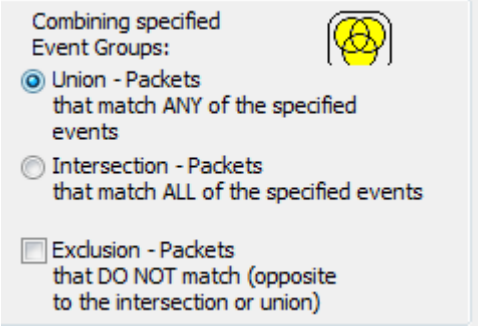


Figure 7.43: Find Dialog

3. From the Search For menu, select a display level such as **Packets**. To search multiple levels, finish steps 3 to 9, and then repeat 3 to 9 for each additional display level.
4. From the Event Groups menu, select an **Event Group**. The menu in the far right of the dialog is context sensitive and changes to reflect the options for that group.
5. In the menu in the far right, select one or more items.
6. Repeat Step 5 for each Event Group of interest for the selected display level.

7. Under Scope, select Current Segment or All Segments to reduce the scope of the search. This applies to old segmented traces, for newer traces leave this option in Current Segment.
8. Under Direction, select **Forward** or **Backward** to select a search direction.
9. Under Origin, select a starting point for the search.
10. Under **Combining Specified Event Groups**, select an option (see the following screen capture).



The options Union, Intersection, and Exclusion let you set conditions on your searches:

- **Union**: To search for **any** of the selected criteria.
  Example: “Find packets with ANY of the following characteristics …”
- **Intersection**: To search for **all** of the selected criteria.
  Example: “Find packets with ALL of the following characteristics …”
- **Exclude**: To **exclude** items from a search. This option works in conjunction with Union and Intersection. You select Union and Exclude to exclude any of the specified traffic. You select Intersection and Exclude to exclude all of the specified traffic.
  Example: “Exclude packets with ANY of the following …” or
  “Exclude packets with ALL of the following …”

1. Repeat Steps 3 through 9 for additional display levels.
2. **Find All** displays all matching packets or transactions in a separate view.
3. **Search in Hidden** includes hidden packets or transactions in the search.
4. Click **OK**.

7.11.1 Event Groups

The Event Groups for Packets are:

- TLP Type
- TLP Header
- TLP Prefix
- TLP Requester ID
- TLP Completer ID
- TLP Data Pattern

- TLP Data Lengths
- TLP Traffic Class
- TLP Tag
- TLP Sequence Number
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number
- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data (see “TS1 and TS2 Event Groups” on page 175)
- TS2 Data (see “TS1 and TS2 Event Groups” on page 175)
- Message Code

The Event Groups for Link Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

The Event Groups for Split Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- Requester ID
- Completer ID
- Status
- Tag
- Address

The Event Groups for NVMe transactions are:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command
- NVMe Errors

The Event Groups for PQI Transactions are:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

The Event Groups for AHCI Transactions are:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

The Event Groups for ATA transactions are:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

The Event Groups for SOP transactions are:

- SOP Information Unit ID
- SOP Errors

The Event Groups for SCSI transactions are:

- SCSI Commands
- Command Status
- Task Management
- Task Management Response
- Errors
- SCSI Logical Unit Numbers

The Event Groups for NVMe Commands are:

- Admin Command Set
- NMVE Command Set
- Submission QID
- Completion QID
- Status
- Errors
- LBA
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

TS1 and TS2 Event Groups

Selecting TS1 Data or TS2 Data options allows further definition of the exact field contents to match via the three dialogs show below. The search algorithm will find the specified TS ordered set on any lane.

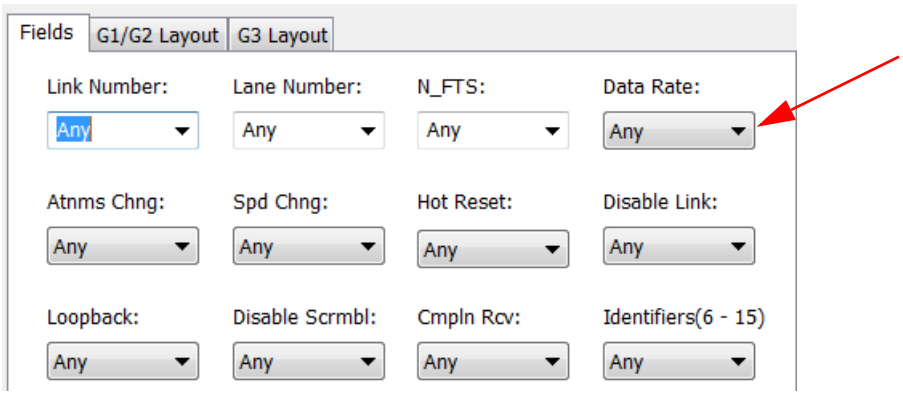


Figure 7.44: TS Data Fields Tab

Select parameters from the drop-down lists to use.

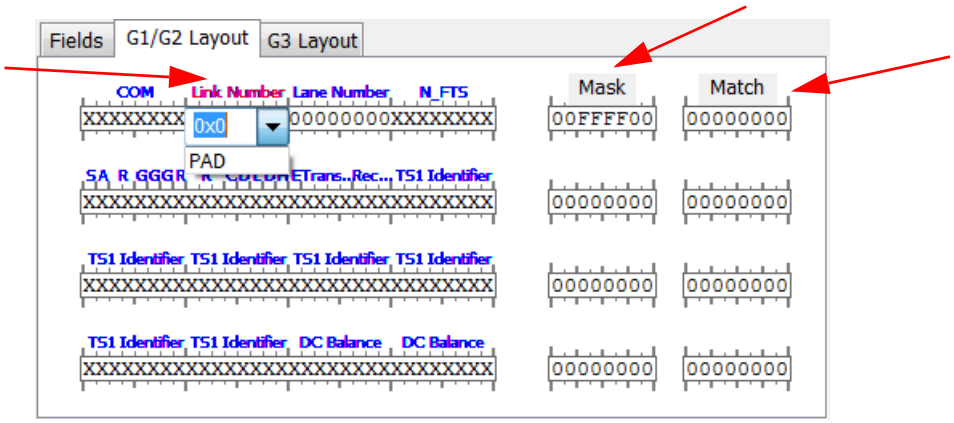


Figure 7.45: TS G1/G2 Layout Tab

Select parameters from the links to use and enter the mask and match values.

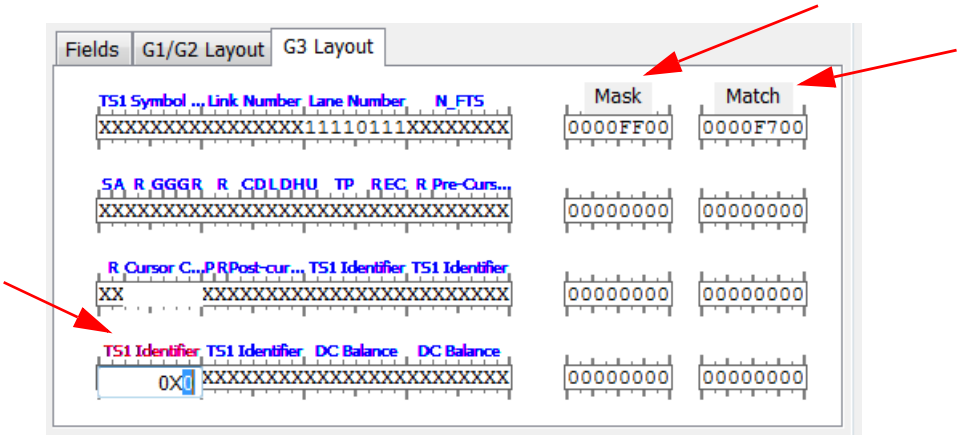


Figure 7.46: TS G3 Layout Tab

Select parameters from the links to use and enter the mask and match values.

7.12 Search for the Next Packet Type

Use Find Next or click to search for the next packet meeting the search criteria.

7.13 Quick Search Feature

As an example, the NVMe_Z3DriveEmulation Trace has been loaded from the C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files (see Figure 7.47).

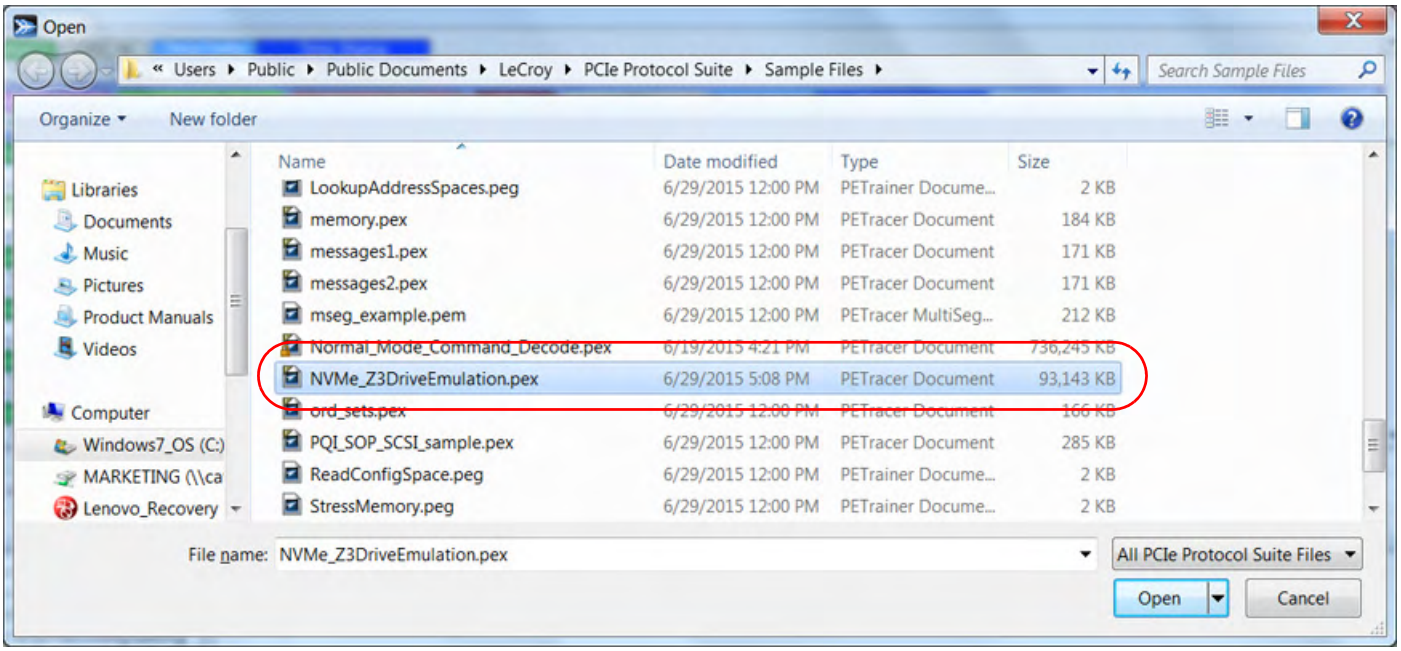

Open
Users ▸ Public ▸ Public Documents ▸ LeCroy ▸ PCIe Protocol Suite ▸ Sample Files ▸
Search Sample Files
Organize
New folder
Libraries
Documents
Music
Pictures
Product Manuals
Videos
Computer
Windows7_OS (C:)
MARKETING (\\ca
Lenovo_Recovery
Name
Date modified
Type
Size
LookupAddressSpaces.peg 6/29/2015 12:00 PM PETrainer Docume... 2 KB
memory.pex 6/29/2015 12:00 PM PETracer Document 184 KB
messages1.pex 6/29/2015 12:00 PM PETracer Document 171 KB
messages2.pex 6/29/2015 12:00 PM PETracer Document 171 KB
mseg_example.pem 6/29/2015 12:00 PM PETracer MultiSeg... 212 KB
Normal_Mode_Command_Decode.pex 6/19/2015 4:21 PM PETracer Document 736,245 KB
NVMe_Z3DriveEmulation.pex 6/29/2015 5:08 PM PETracer Document 93,143 KB
ord_sets.pex 6/29/2015 12:00 PM PETracer Document 166 KB
PQI_SOP_SCSI_sample.pex 6/29/2015 12:00 PM PETracer Document 285 KB
ReadConfigSpace.peg 6/29/2015 12:00 PM PETrainer Docume... 2 KB
StressMemory.peg 6/29/2015 12:00 PM PETrainer Docume... 2 KB
File name: NVMe_Z3DriveEmulation.pex
All PCIe Protocol Suite Files
Open
Cancel

Figure 7.47: Location of Trace File to be Loaded

Select the NVMe_Z3DriveEmulation.pex file and click on Open.

The Main Menu will look like Figure 7.48 after you chosen to look for NVMe commands and removed unrelated traffic.

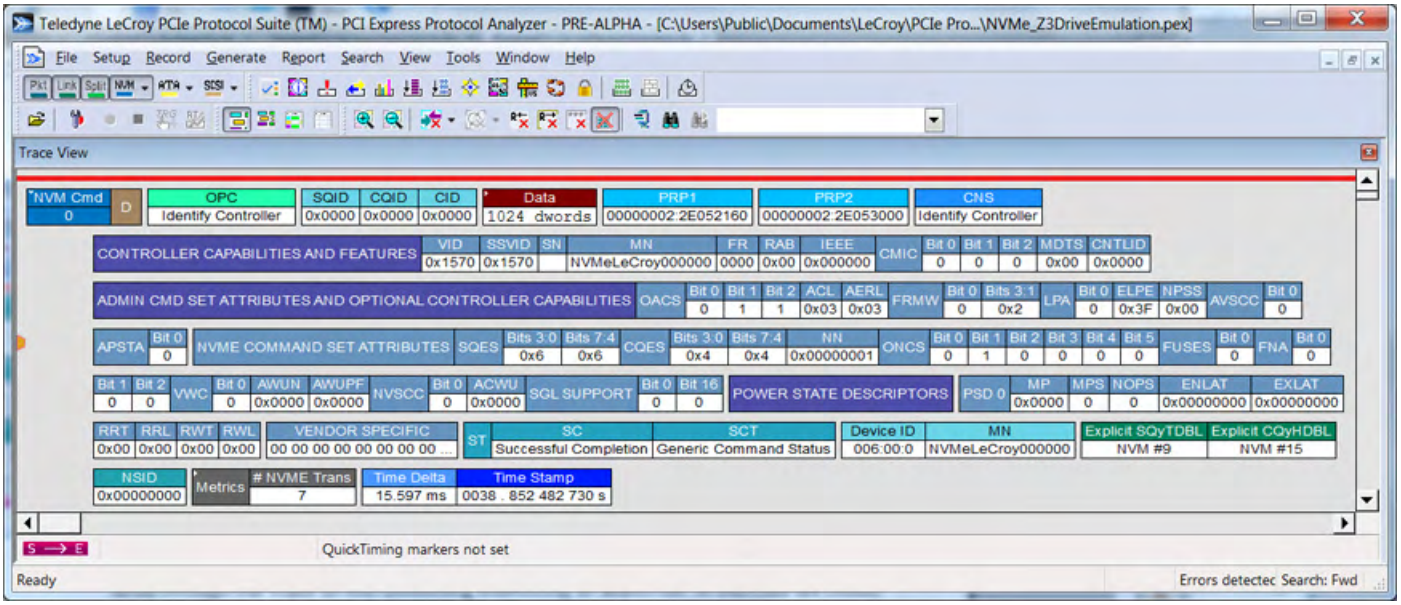


Figure 7.48: Main Menu with NVMe_Z3DriveEmulation Trace Loaded

Enter a term to search for in the Search Window.

In this case, we chose “NVM #66

.

Place the cursor inside the Search Window and click the Enter key. The results are shown below (see Figure 7.49).

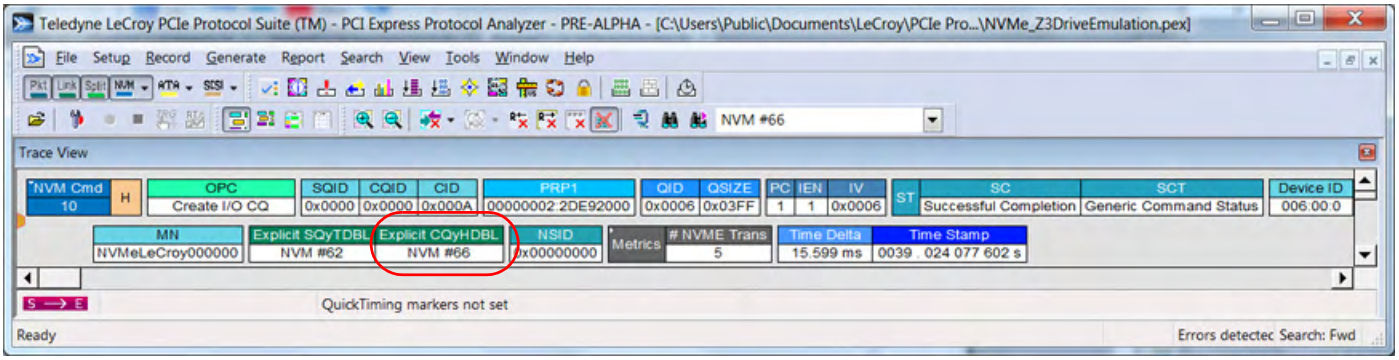


Figure 7.49: Search for NVM #66

Once the packet in the Trace has been found, the NVM #66 can be seen to be part of a doorbell event (Explicit SQyTDBL: NVM #62 with the response of Explicit CQyHDBL NVM #66).

This was just an example, you can search for any of the pre-defined terms (Figure 4.11 on page 34) or chose your own term or event to search for.

If you started Searching in the middle of the Trace the following windows will pop up:

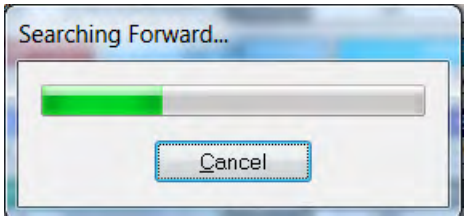


Figure 7.50: Search Progress Window

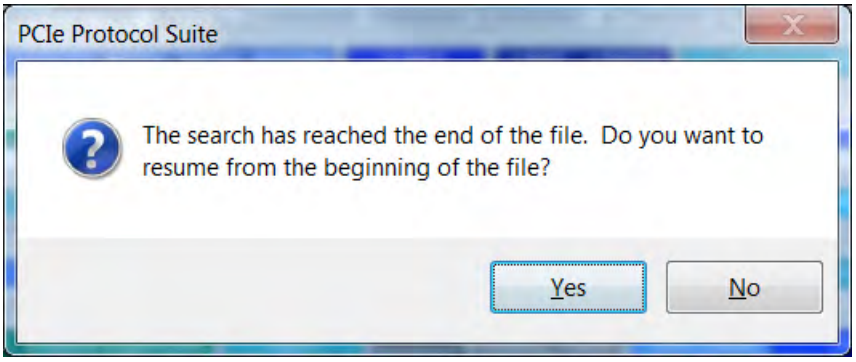


Figure 7.51: Resume Searching From Beginning of Trace

If you select Yes, the tool will continue searching from the start of the Trace, then the following window will pop up:

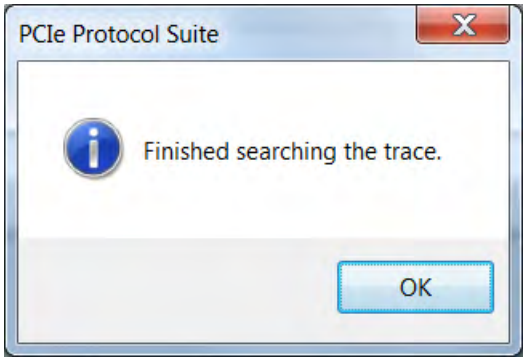


Figure 7.52: Finished Searching Trace

If the tool hasn't moved to a new Packet, the term being Searched for was not found.

Chapter 8

Display Options

8.1 Setting Display Options

Display Options allow you to customize the colors and formats of displayed traffic.

To open the Display Options dialog at the General tab, Select **Setup > Display Options** from the menu or click the **Display Options** button on the toolbar.

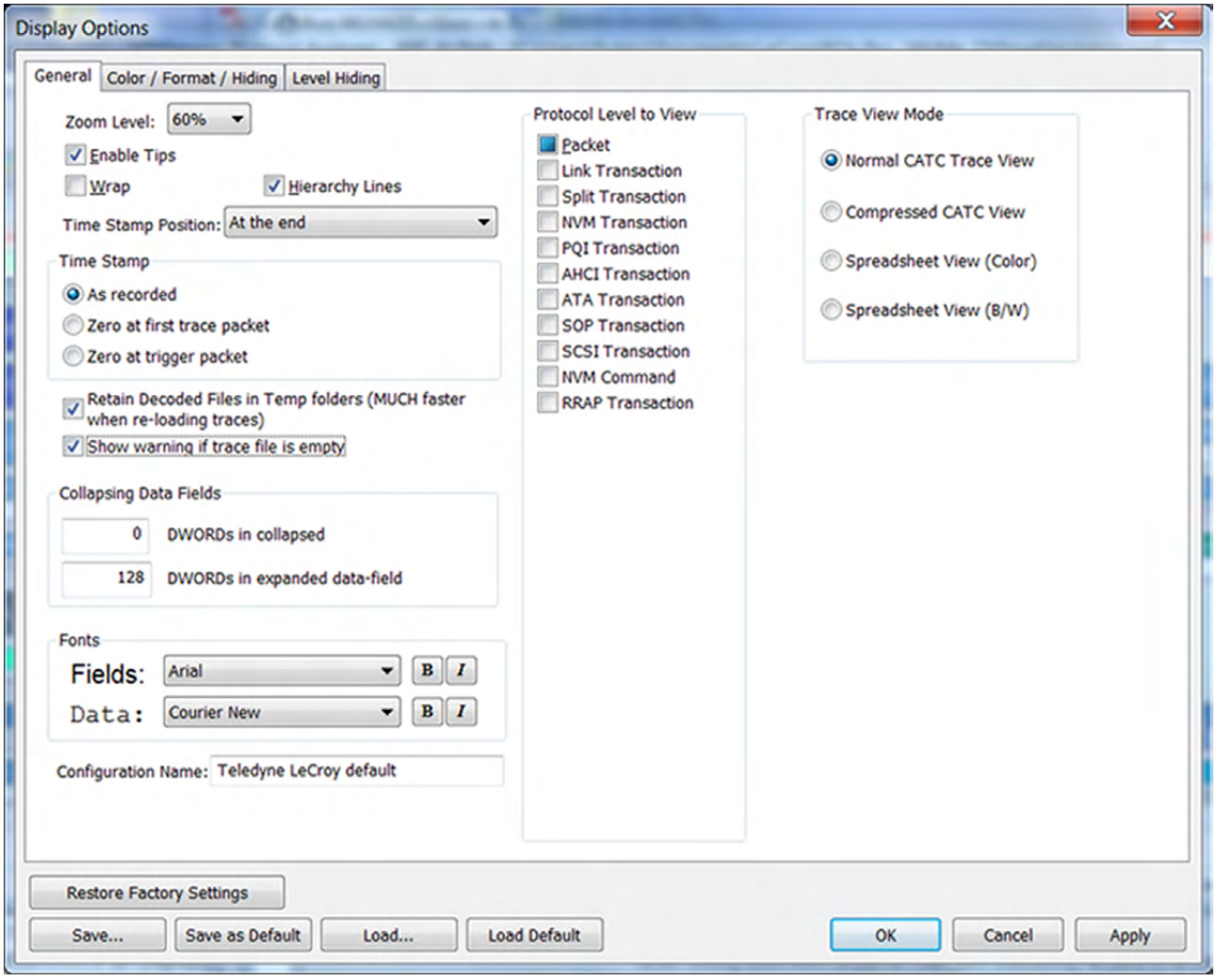


Figure 8.1: Display Options Dialog - General Tab

8.2 Specifying General Display Options

The Display Options General tab allows you to specify:

Zoom Level: Defines the size of packet fields in the packet view. Zoom level is adjustable as 10, 20, 40, 60, 80, 100, 120, 140, 160, 180 and 200 percent.

Enable Tool tips: Allows information to be displayed on a packet by resting your mouse pointer over it.

Wrap: Allows packets, Link Transactions, and Split Transactions to wrap within the display.

Hierarchy Lines: Adds lines to the trace view indicating relations between packets, Link Transactions, and Split Transactions.

Timestamp position: Moves timestamp location from end of packet to beginning of packet, or merges it with the packet number.

Retain Decoded Files: Decoded Files are retained in Temp folders, which makes re-loading the trace much faster.

Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed.

Protocol Level to View: Allows the CATC Trace to be displayed in different hierarchical levels: Packets, Link Transactions, Split Transactions NVMe, PQI, AHCI, ATA, SOP and SCSI command transactions.

Time Stamp: Gives you options for setting the timestamp to zero for either the first CATC Trace packet or the trigger packet or for leaving the stamp unchanged as it was originally recorded.

Trace View Mode: Displays Normal CATC Trace View, Compressed CATC View, Spreadsheet View (Color), and Spreadsheet View (B/W).

8.2.1 Fonts

Fonts: Allows the appearance of field text and/or data text to be defined.

8.2.2 Configuration Name

Display Configuration Name: This field is used to enter a text string to be associated with the current set of Display Options. This name is saved with the Display Options file, and appears as part of the title of the packet view window that uses this set of Display Options.

8.2.3 Color, Format, and Hiding Options

The Color/Format/Hiding tab allows you to customize the colors and formats associated with each field in the CATC Trace and to selectively hide fields or packets. You access these display options by selecting **Setup > Display Options > Color/Format/Hiding** tab.

The Color/Format/Hiding property page lets you set how fields display in a CATC Trace. This property page lets you set field color and data format (binary, hex, decimal, ASCII), and lets you hide selected fields from the display (see Figure 8.2 on page 183).

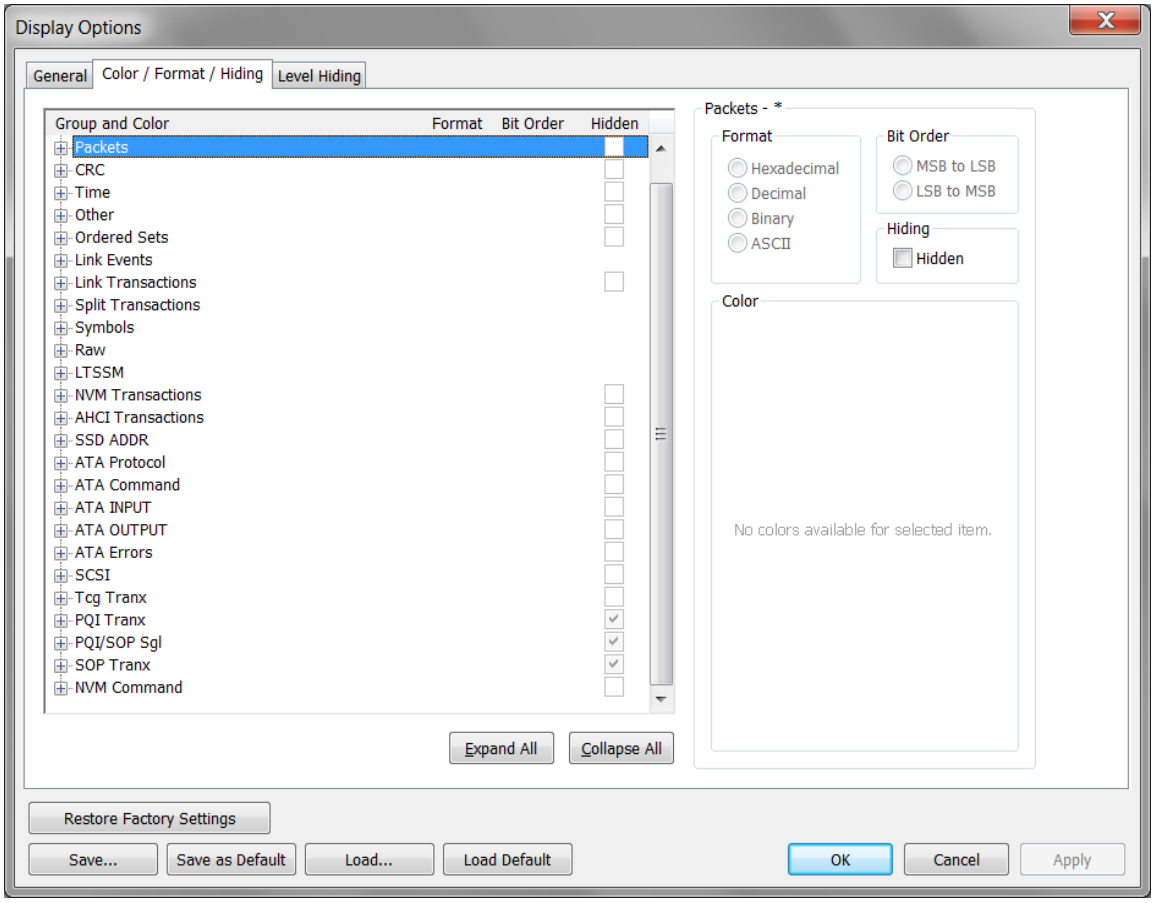


Figure 8.2: Display Options Dialog - Color/Format/Hiding Tab

8.2.4 Setting Field Colors

The Field Colors tab allows you to customize the colors associated with each field used in the packet view.

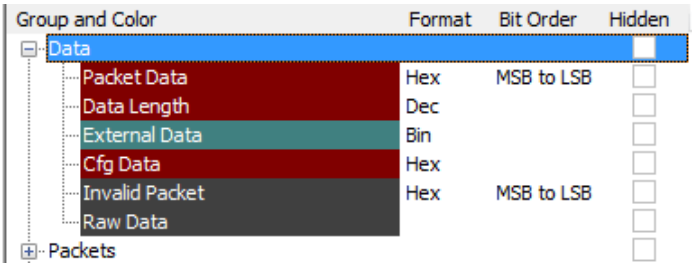
You may experiment with this option to achieve a color combination that suits you.

Select or change the trigger color using the color buttons labeled **- Packet #** and **+ Packet #** (before and after trigger) found under the Packet# section of the Field Colors window.

You select or change a color by clicking the appropriate color button. This action causes a color palette to pop up. Select the desired color and press OK.

1. Click **View > Set Display Options** to open the Display Options dialog.
2. Select the **Color/Format/Hiding** property page.

3. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group. Each field has a color, as shown below:



4. Click the colored cell that you want to change. A color palette appears.
5. Click a color in the palette, then click **Apply** or **OK**.

Note: The colors of the following Frame types cannot be changed:

- Invalid Data (frame error) field (red)
- Softbit Errors (yellow)

You can also change color by left-clicking a field in the CATC Trace and selecting Color from the pop-up menu

.

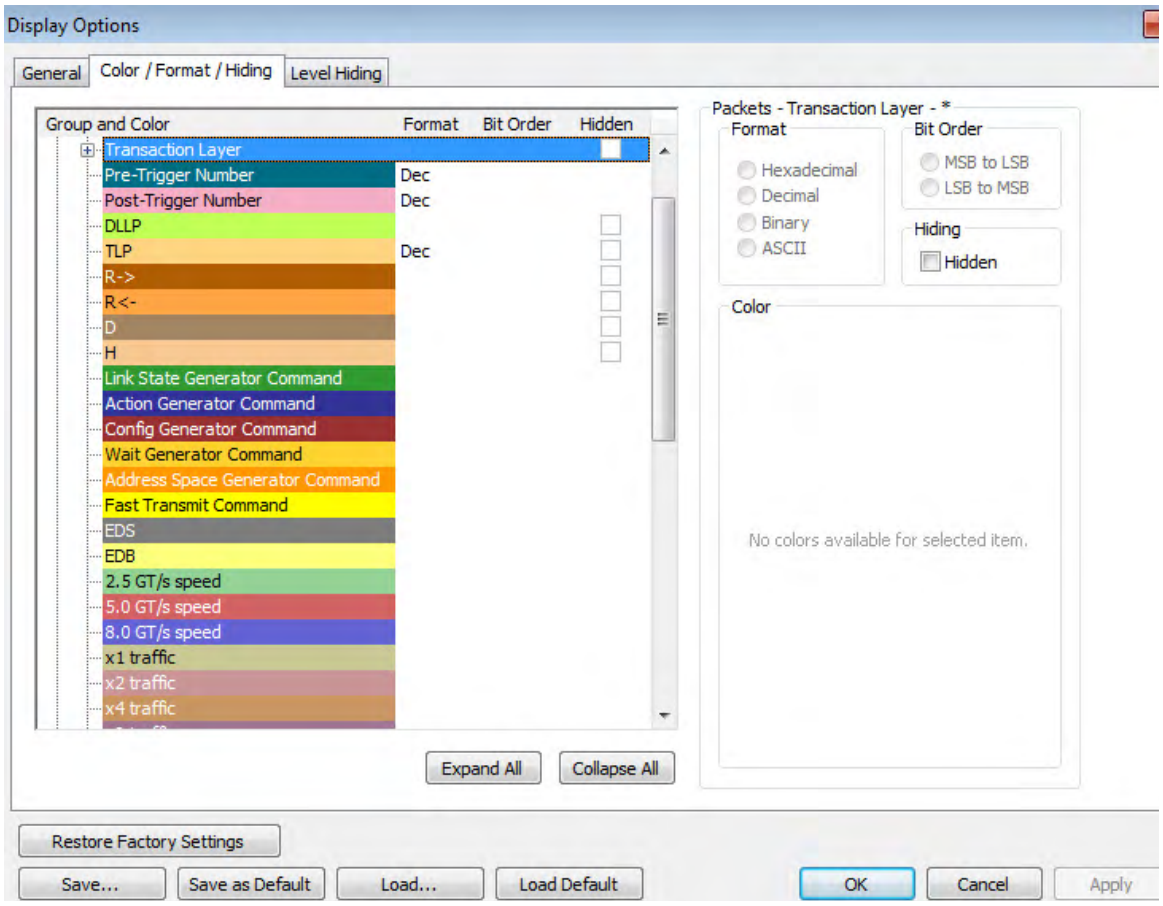


Figure 8.3: Display Options Dialog Color/Format/Hiding Tab

8.2.5 Changing Field Formats

The Field Formats tab allows you to define the way various numeric fields are shown in the packet display. You can select Hexadecimal, Decimal, Binary, or ASCII for certain fields or groups of fields.

To change a field's format, click the plus sign (+) next to a field in the list. This causes the selected item to expand so you can see its constituent sub-fields. Select a sub-field, and then choose the format from the formatting choices that appear at the bottom of the window.

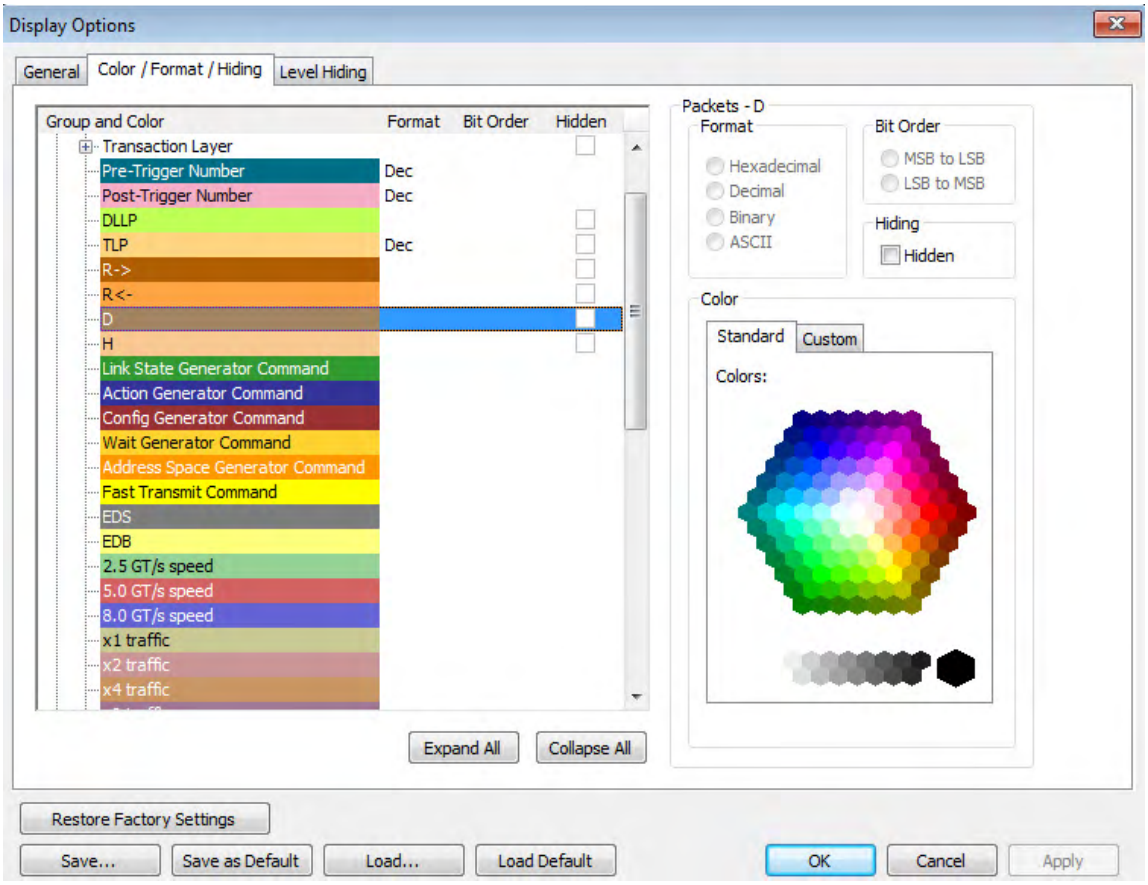
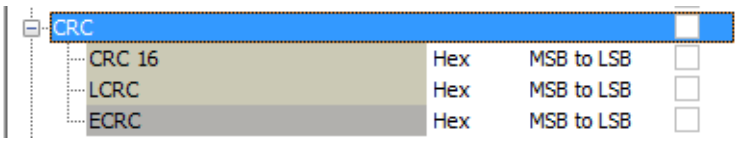


Figure 8.4: Display Options Dialog Color/Format/Hiding Tab

To change the format of alphanumeric characters in a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group (as shown above).
2. Click the **row** representing the field that you want to reformat. If the field can be reformatted, the format options at the top of the dialog become active, as shown below:



3. Select a **format**.
4. Specify the bit order in the displayed fields by checking/unchecking the **MSB > LSB** checkboxes.
5. Click **Apply** or **OK**.

8.2.6 Hiding Fields

To hide a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group that has the field(s) you want to hide. The group expands to show the individual fields within the group (as shown above).
2. Click the **checkbox** in the row representing the field that you want to hide.
3. Click **Apply** or **OK**.

8.2.7 Hiding Levels

The Level Hiding page lets you hide traffic by Event Group. If you select one or more event types from the Event Group list, the selected types are hidden from the CATC Trace.

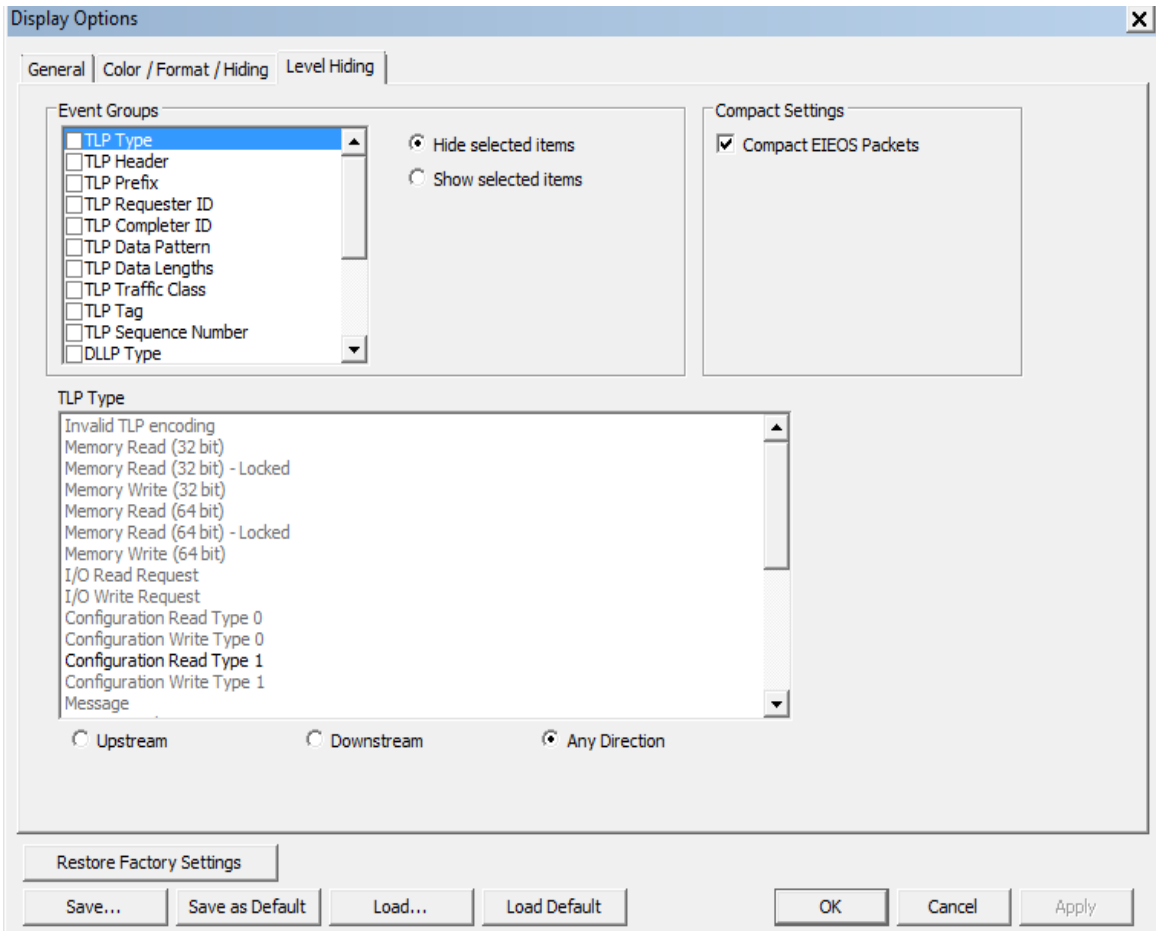


Figure 8.5: Display Options Dialog - Level Hiding Tab

To hide a level:

1. Select an Event Group.
2. Select whether to **Hide** or **Show selected items**.
3. Select **Upstream, Downstream**, or **Any Direction**.
4. (Optional) Select **Compact EIEOS packets**.
5. Click **OK**.

The Event Groups for Packets are:

- ❑ TLP Type
- ❑ TLP Header
- ❑ TLP Requester ID
- ❑ TLP Completer ID
- ❑ TLP Data Pattern
- ❑ TLP Data Lengths
- ❑ TLP Traffic Class
- ❑ TLP Tag
- ❑ TLP Sequence Number
- ❑ DLLP Type
- ❑ DLLP Header
- ❑ DLLP Virtual Channel
- ❑ ACK/NAK Seq Number
- ❑ Ordered Sets
- ❑ Link Event
- ❑ Direction
- ❑ Errors
- ❑ TS1 Data
- ❑ TS2 Data

The Event Groups for Link Transactions, and PQI Transactions are:

- ❑ TLP Type
- ❑ Traffic Class
- ❑ Virtual Channel
- ❑ Direction
- ❑ RequesterID
- ❑ CompleterID
- ❑ Status
- ❑ Tag

The Event Groups for Split Transactions are:

- ❑ TLP Type
- ❑ Traffic Class
- ❑ Virtual Channel
- ❑ Direction
- ❑ RequesterID
- ❑ CompleterID
- ❑ Status
- ❑ Tag
- ❑ Address

The Event Groups for NVMe transactions are:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command
- NVMe Errors

The Event Groups for PQI Transactions are:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

The Event Groups for AHCI Transactions are:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

The Event Groups for ATA transactions are:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

The Event Groups for SOP transactions are:

- SOP Information Unit ID
- SOP Errors

The Event Groups for SCSI transactions are:

- SCSI Operation
- Command Status
- Task Management
- Task Management Response
- Errors
- SCSI Logical Unit Numbers

The Event Groups for NVMe Commands are:

- Admin Command Set
- NVME Command Set
- Submission QID
- Completion QID
- Status
- Errors
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

8.3 Load a Previously Saved Display Options File

If you have previously saved Display Options, you can load them by opening the Display Options dialog and clicking the **Load** button. A dialog opens to let you load a previously saved display options file.

1. Click **Load** to use a previously defined display options file.
2. When you see the Open File pop-up window, enter the name of the file you want to load and click **Open**.
3. When the PCIe Protocol Suite™ software returns you to the Recording Options menu, click **OK** to activate the display options you selected.

8.4 Saving Display Options

If you have customized the Display Options and wish to save them, you can do so by clicking the **Save** button, then entering a unique file name. The **.opt** extension is added by default.

Setting the Defaults: Save the currently specified Display Options to the file name: **default.opt** by clicking **Save As Default.** When the Analyzer software begins execution, it automatically loads the **default.opt** file, if one exists.

Chapter 9

BitTracer Recording

Note: BitTracer Recording is an optional feature.

The Summit T24 analyzer has an optional **BitTracer** data capture mode, which captures bi-directional link traffic in raw format. The BitTracer recording mode captures and displays traffic before lane-to-lane de-skew operations and before descrambling of 10b bytes. The BitTracer mode includes support for multiple logical links (bifurcations) on a single physical link.

The BitTracer recording mode has its own user interface, which provides characterizations of link traffic that are not available in the standard protocol analyzer mode.

You can export BitTracer recordings for viewing in CATC Trace format.

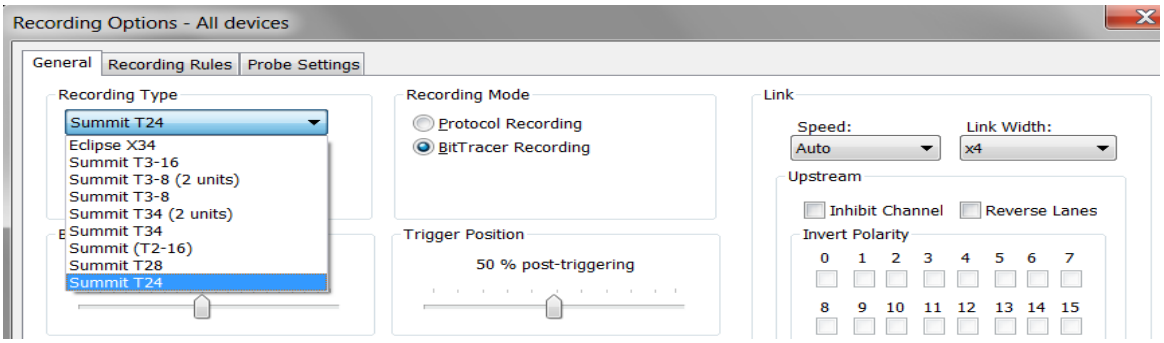
Note: This feature can be included at initial purchase or added in the field with a software upgrade license. To obtain a software license key to add this feature, contact Teledyne LeCroy.

Lane Deskew Bypass in **Recording Options** prevents lanes from being bonded by the analyzer, allowing you to troubleshoot problems with physical layer.

9.1 Enabling BitTracer Recording

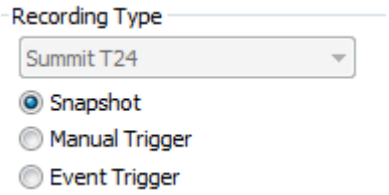
To enable the BitTracer recording mode, open the **Recording Options**.

In the Target Analyzer section of the General tab, select **Summit T24.**



In the Recording Mode section, select **Bit Tracer Recording.**

.

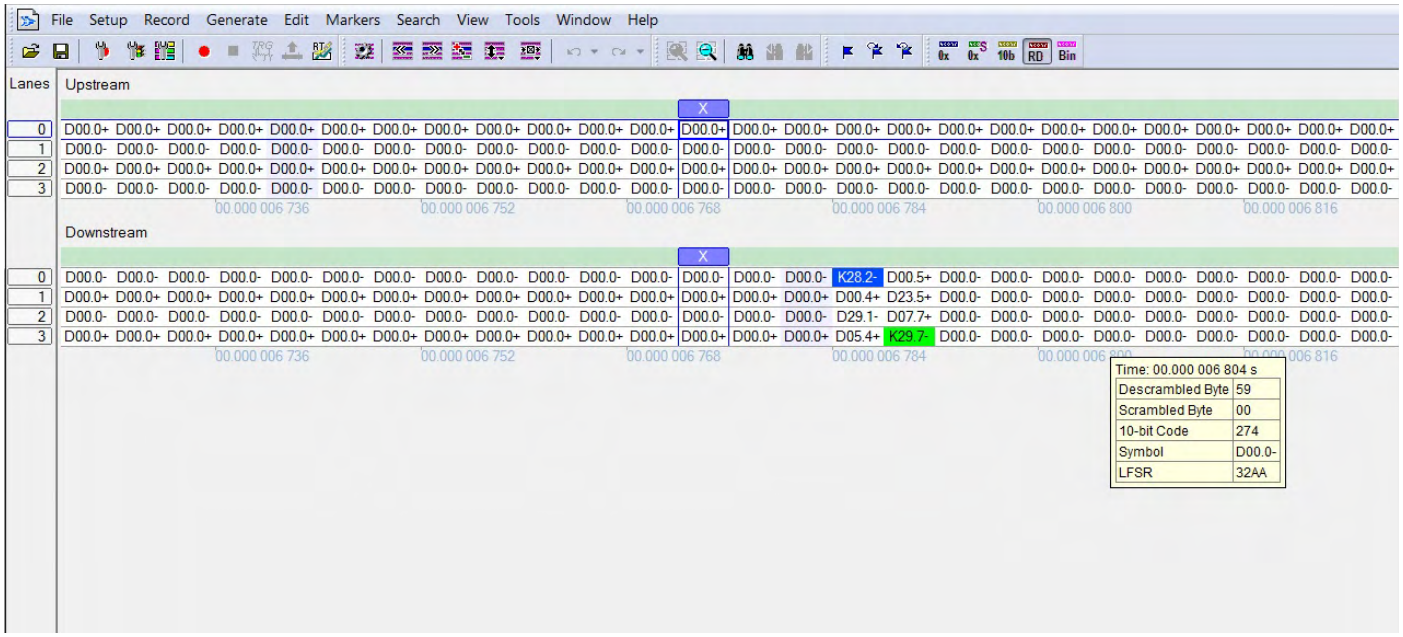


In Bit Tracer Recording, you can use the Snapshot, Manual Trigger, and Event Trigger recording types.

Note: You can also use other standard Recording Options, such as Link Width, Buffer Size, and Lane Polarity Settings, to characterize the link.

9.2 Views Available for Captured Data

BitTracer mode displays captured data lane-by-lane and byte-by-byte in each direction (upstream and downstream), with the time scale progressing left to right.



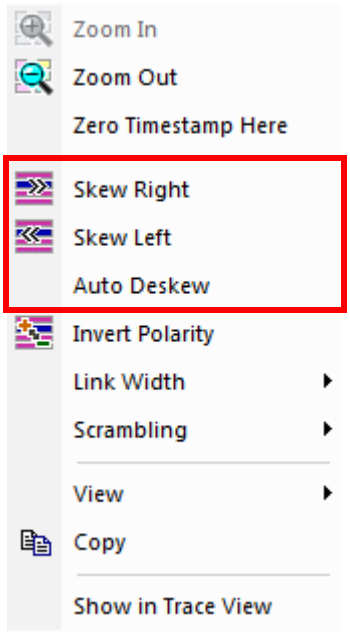
Other views are provided for timing measurements, marker placement, physical layer errors, captured symbol types, packets, events, and decoding of ordered sets and packets. You can view any or all displays simultaneously, using the **Windows** selection in the View menu.

9.3 De-skewing Data

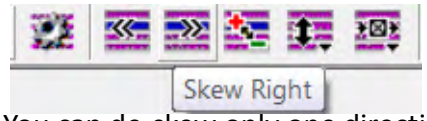
By default, BitTracer recordings display captured data in time de-skewed format, across all lanes for both directions. But it is possible, for debugging purposes, to bypass this de-skew using the **Lane Deskew Bypass** check box in **Recording Options**.

When lanes are not de-skewed, individual bytes are as they were captured on the recorded link, before the receiver device on the link (or the receiver logic on the PCIe Protocol Suite analyzer) has performed lane-to-lane de-skew operations.

You can manually skew the captured data, left or right, in increments of one symbol time, using the associated toolbar buttons.



You can automatically de-skew an entire lane direction. First, left-click on the direction in the data window. Then right-click to display a popup menu. Then select **Auto De-Skew.**



You can de-skew only one direction for each right-click operation. To automatically de-skew the opposite direction, first left-click on that direction in the data window.

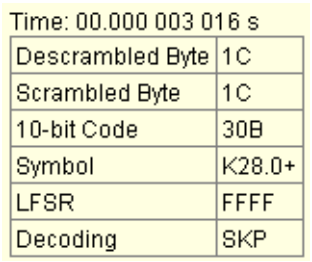
Note: The skew observed in the bit tracer is the actual skew of the lanes in the link plus the skew introduced by the analyzer interface. The De-skew Bypass option is not intended for skew measurements or estimations.

9.4 Data Display Formats

To display traffic in K/D symbol (with Running Disparity indicated), scrambled, descrambled, 10-bit, and Binary code formats:

- Use the toolbar.

- Right-click to display a menu.
- Place the cursor over any given byte to display all byte formats (including an LFSR value) in pop-up list.


Time: 00.000 003 016 s

Descrambled Byte	1C
Scrambled Byte	1C
10-bit Code	30B
Symbol	K28.0+
LFSR	FFFF
Decoding	SKP

Note: Descrambled values can only be displayed after the first recorded skip ordered set. Data prior to the skip is displayed in scrambled values, due to the unknown LFSR.

Note: For Binary Data Display Format, bits are shown in order of transmission on the bus.

9.5 Color-Coding of BitTracer Contents

To increase visual understanding of BitTracer displays, different symbol types have color-coding:

- Presence or non-presence of a lane's byte-lock
- Idle data characters (D0.0)
- K codes
- Invalid 10b symbols
- Signal presence
- Background of the Markers Bar (see "Markers Bar" on page 195) (color coded according to traffic speed).
- All symbols of a TS1/TS2 ordered set

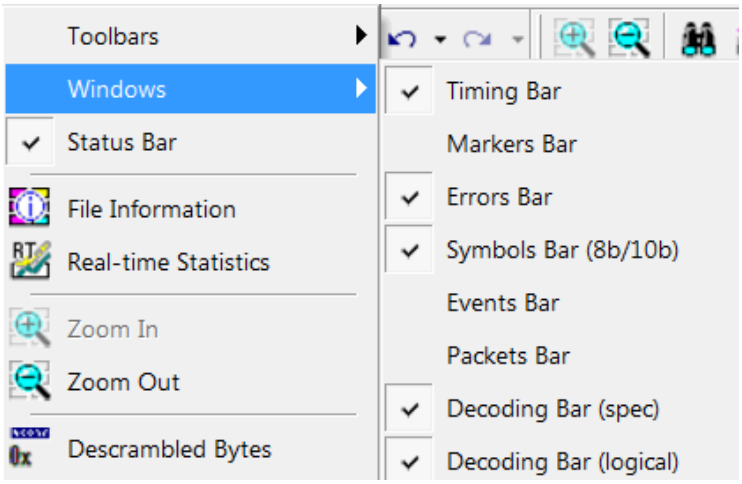
By default, these color selections match the standard color selections used in the CATC Trace format. You can modify them in the Display Options menu, accessible from the Main toolbar or the Setup menu.

9.6 Report and Analysis Windows

In the report windows, BitTracer mode provides several functions to analyze traffic:

- Statistical information
- Timing measurements
- Packet decoding

To activate/deactivate a report window, use **Views > Windows**



You can rearrange the report windows.

All report windows are dockable.

9.7 Timing Measurements Bar

BitTracer mode provides timing measurements on captured data (see the following figure):

- Measurements from the Trigger position relative to user-selected X and Y markers
- X-Y measurements
- Measurements between user-defined markers

9.7.1 Markers Bar

The Trigger marker T is at the point where BitTracer recognized the user-defined trigger condition.

To set an X marker X, left-click anywhere in the data display, except for the light gray bar located above the data and below the directional label.

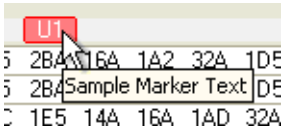
To set a Y marker Y .right-click anywhere in the data display, except for the light gray bar located above the data and below the directional label.

To define a marker, select the **Set Marker** command in the Markers menu or use the **Toggle Marker** icons in the toolbar. You can also use the Jump to Next or Previous marker icons in the toolbar.

User-defined markers are numbered in the order they were placed:

- U1 U1, U2, and so on in the upstream direction
- D1, D2 D2, and so on in downstream direction.

You can set a marker with text using the **Set Marker with Text...** command in the Markers menu. After setting the marker, when the mouse pointer is on the marker symbol, the marker text displays as a tooltip.



You can also display the Markers window, which lists all markers and their locations, including a hyperlink for each.

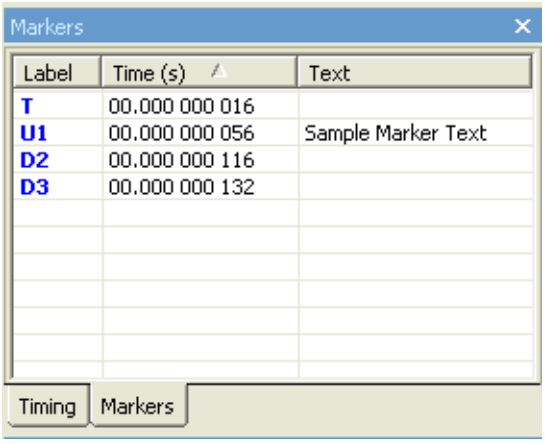


Figure 9.1: Markers Window

Timing measurements between all combinations of X, Y, U, and Trigger cursors are in the Timing window.

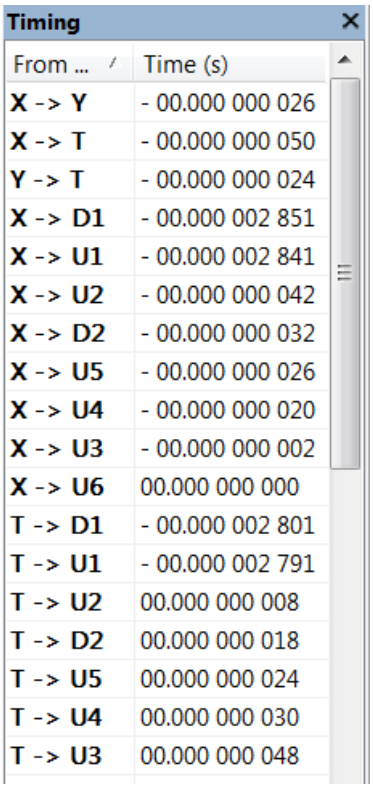


Figure 9.2: Timing Window

9.8 Errors Bar

BitTracer mode provides a summary of 10b errors (invalid symbols) and disparity errors in the Errors window (see Figure 9.3 on page 197). The window shows the total error count and errors per-lane for each error type. Hyperlinks allow jumps to selected errors.

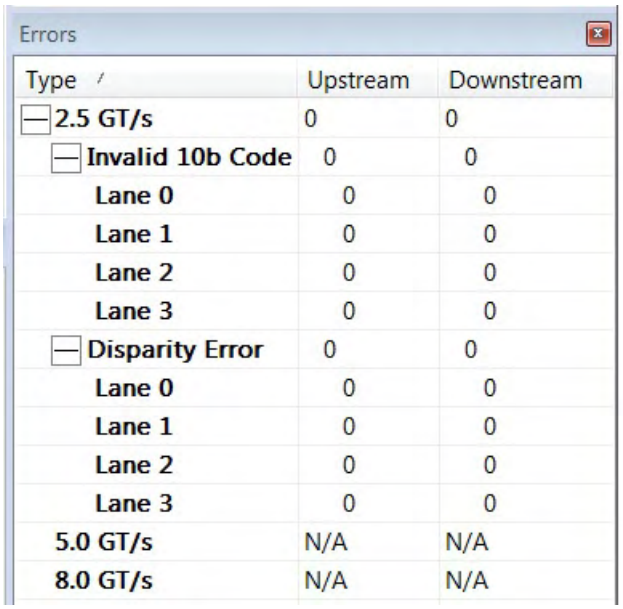


Figure 9.3: Errors Window

BitTracer mode also highlights errors:

- Invalid symbols have a black background.
- Bytes with incorrect running disparity have red borders.

9.9 Symbols Bar

The Symbols window provides a summary of the different symbol types captured, by quantity and direction, and includes hyperlinks for jumps to selected symbols. Expanding the **+** sign at the left of each symbol provides a summary of symbols by lane.

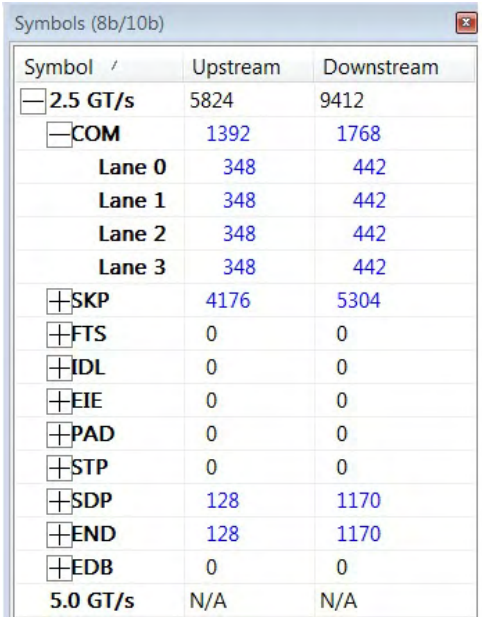


Figure 9.4: Symbols Window

9.10 Events Bar

The Events report window summarizes Link Up, Link Down, and Speed Switch events for Upstream and Downstream.

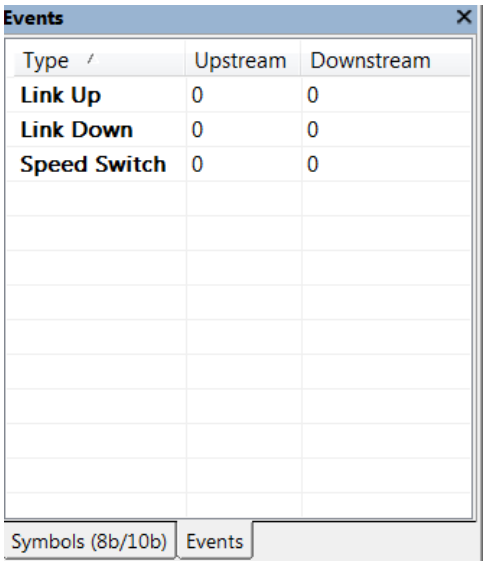


Figure 9.5: Events Window

Note: The table entries are hyperlinks.

9.11 Packets Bar

The Packets report window summarizes packet types detected in the file (see "Packets Window" on page 200).

Note: To obtain packet types, you must perform a post-capture "Analyze" step. After capture, when you open the Packets Bar for the first time, items can display the command "Analyze". To start the analysis, click the word **Analyze**. After analysis finishes, the results are saved with the file. Therefore, you do not need to click **Analyze** the next time.
The table entries are hyperlinks.

Note: If you edit anything, the results are no longer valid, and the system requires you to click **Analyze** again.

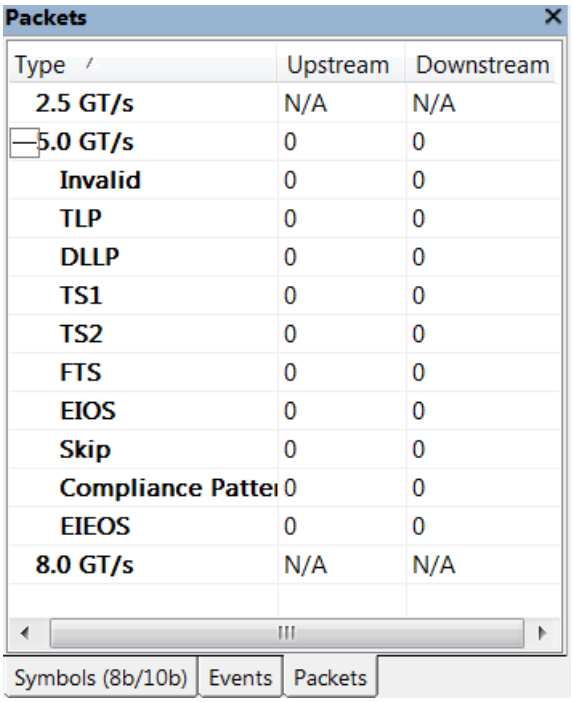
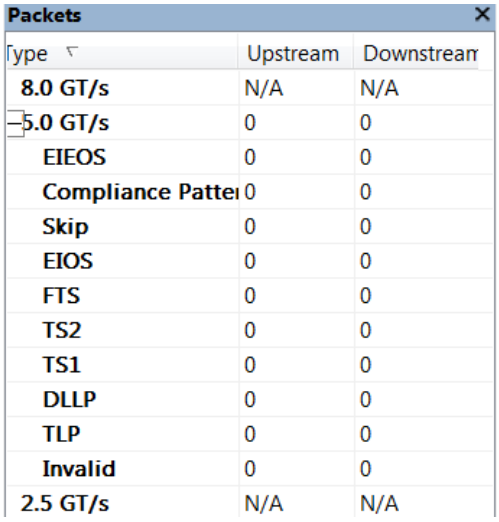


Figure 9.6: Packets Window

After analysis, the Packets Bar looks like the following:



9.12 Decoding Bar

If you select them in the data view, or search or jump locates a feature, BitTracer mode displays ordered sets and packets in the Decoding window (see “Decoding Window” on page 201):

- **Logical view** is identical to CATC Trace format.
- **Specification view** provides a more elementary display. The Specification view includes an option to display data in hex or binary format.

Note: Packets and ordered sets translate directly to this view from data capture and use any post-capture skew manipulations you add, or use natural lane-to-lane skew present on the link if you have not added post-capture skew manipulations. Typically, you would perform an Auto De-Skew before viewing ordered sets and packets in this view.

Use the left and right arrows to search for the next or previous symbol type.

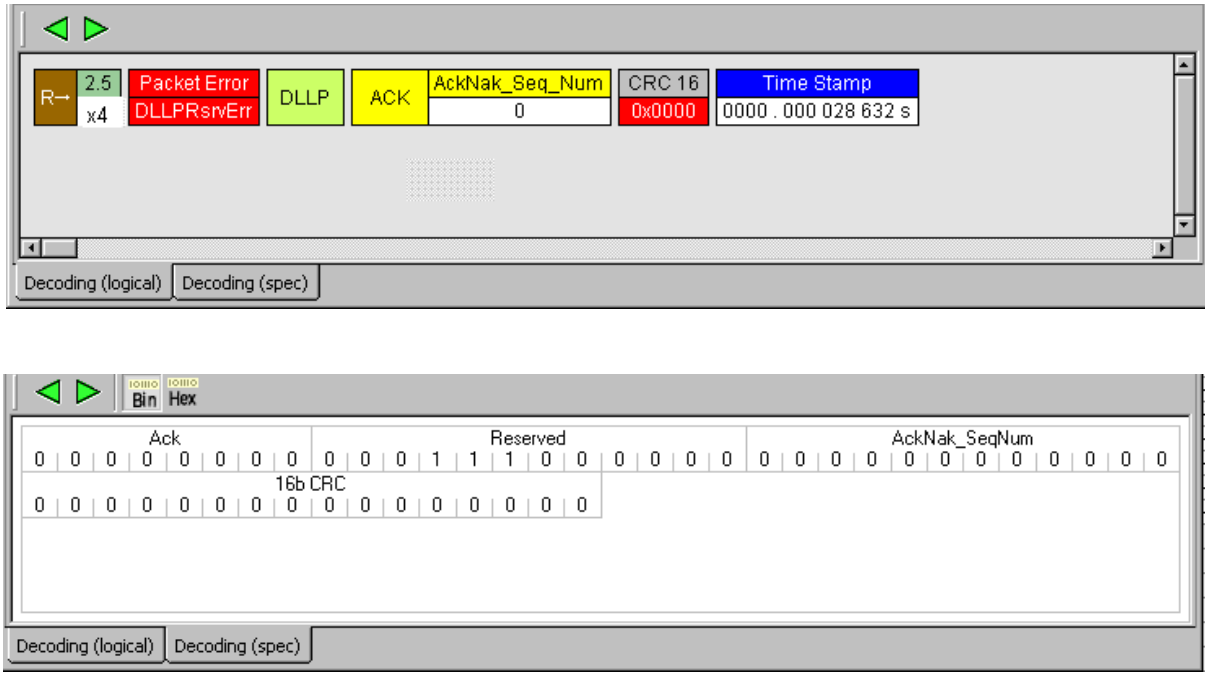


Figure 9.7: Decoding Window

9.13 Search

To search, use the Search toolbar.

Clicking the **Search** icon displays the Search window (see “Search Window” on page 202).

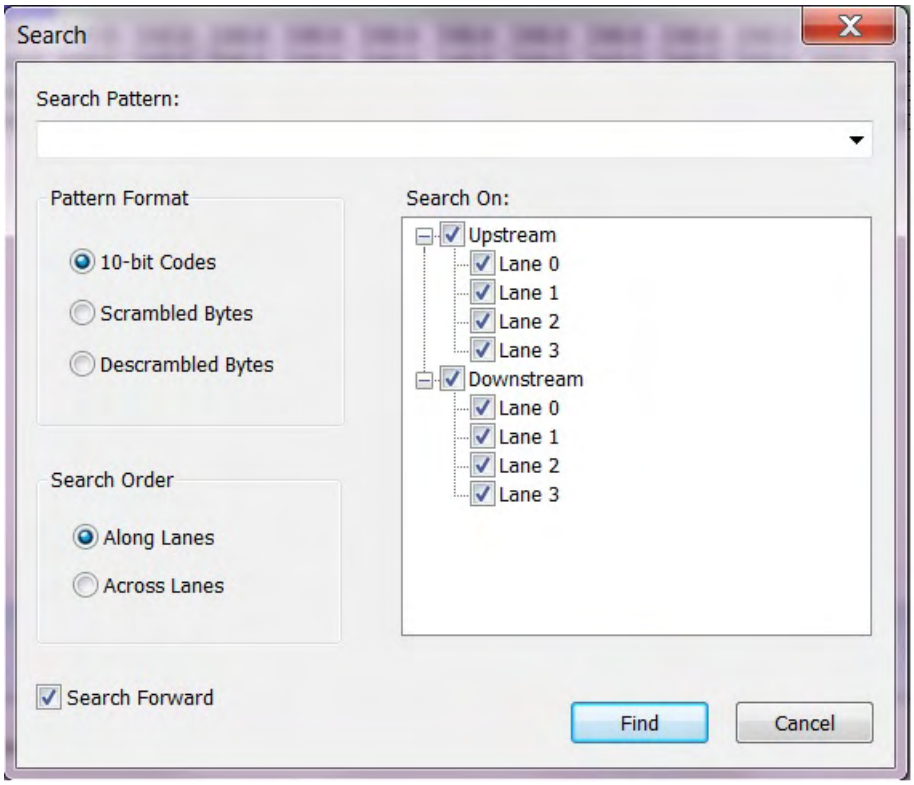


Figure 9.8: Search Window

You can copy data shown in the BitTracer display across a lane (horizontally) or across multiple lanes (vertically), and then paste it into the Search Pattern window.

The Search Pattern window stores previous search values, which you can recall by selecting the Search Pattern drop-down button.

In the Pattern Format section, select to search in 10-bit Codes, Scrambled Bytes, or Descrambled Bytes format.

In the Search Order section, select to search Across Lanes (multiple lanes, vertically) or Along Lanes (individual lanes, horizontally).

To define the direction (upstream or downstream) and the lanes on which to search, use the Search On section.

9.14 Link Configuration

Use the toolbar icon or right-click in the data views to display the Link Configuration dialog. This dialog allows you to associate logical lanes with physical lanes, thereby providing support for lane bifurcation (multiple logical links on the same physical link).

After logical lanes map to physical lanes, BitTracer mode reconfigures the display to show the selected logical link (and the logical link width, as the link width selected in the dialog).

Use the arrows to force symbol time skew on any lane.

Use the polarity checkbox to invert lane polarity on the selected lane or use the **+/-** toolbar icon.

Use the scrambling option to select a scrambling algorithm, as per specification 1.0a or legacy specification 1.0.

Note: This dialog applies to one direction at a time (upstream or downstream). Left-click in the direction in the data display to edit the configuration for that direction.

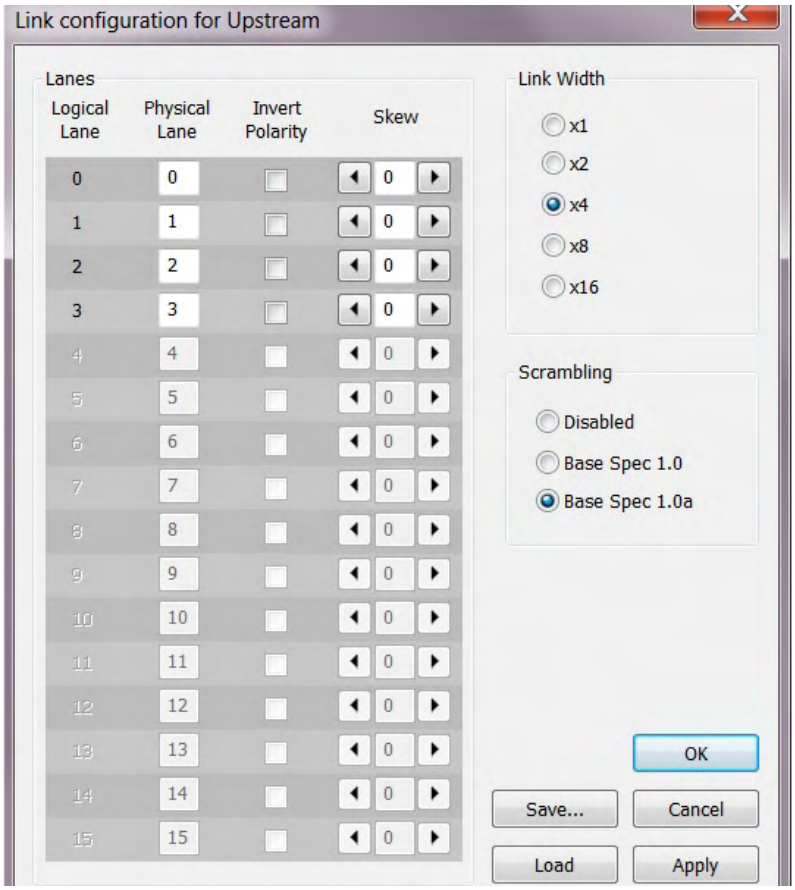
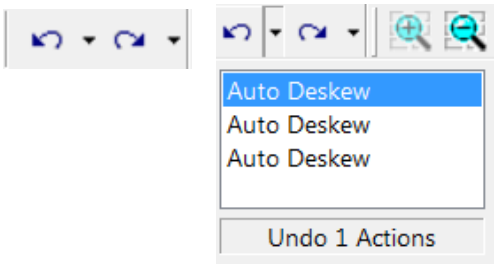


Figure 9.9: Link Configuration Dialog

As you perform operations that affect display configurations, the application records them. To undo or redo operations, use the Undo and Re-do icons on the toolbar (see the following figure).



9.15 Export of BitTracer Capture to CATC Trace Format

You can export BitTracer captures to standard CATC Trace file formats, selecting the **Export** option from the File menu.

Note: You should use the Auto De-skew feature before using the export feature.

The exported CATC Trace keeps association information with the original BitTracer file. Such traces scroll synchronously when you select the **Synchronize Traces** option in the Windows menu.

You can navigate between BitTrace and CATC Trace using the **Show in Trace View/ Show Packet in Raw Trace** context menu.

9.15.1 Exports Involving Multiple Logical Links on One Physical Link

If a single BitTrace capture contains more than one logical link, you can export each logical link to CATC Trace format. You may then cascade or tile the various BitTracer exports, which then scroll together in linked fashion, along with the original BitTracer file. The Export dialog provides options to export a limited range within the BitTrace capture and to automatically open the exported capture in CATC Trace format.

9.15.2 Export To CSV Text

Select **File > Export > Packets to CSV Text** to display the Export Packets to comma delimited text dialog. Select desired options from the From and To Segment, Marker and Time drop-down lists (see Figure 9.10 on page 205).

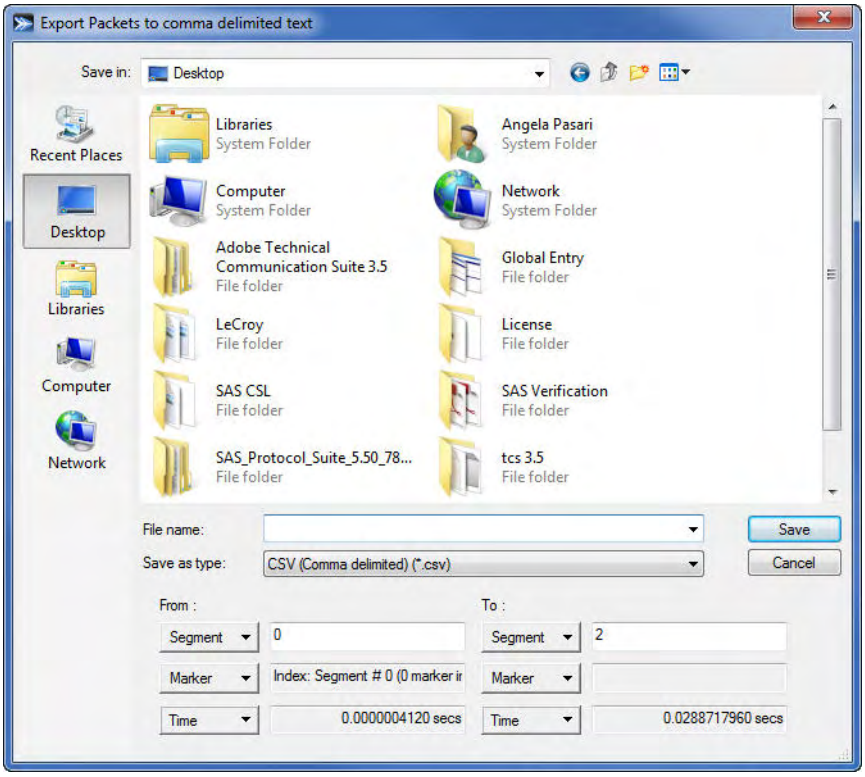


Figure 9.10: Export Packets to Comma Delimited Text Dialog

9.16 Compressing and Expanding the Data View

You can compress (zoom out) the horizontal timing of the displayed data to view higher-order link behaviors. You can expand (zoom in) to examine higher-resolution views.

To zoom in or zoom out, right-click the data view, then select a command or select a zoom icon on the toolbar.

Alternatively, to zoom in, left-click and drag across a desired range of data.

9.17 Opening and Saving BitTracer Captures

You can save BitTracer captures in various file types.

You can collate and archive these files for transport, using the **Export to Compressed Archive** feature in the File menu.

The main BitTracer files have a ***.peraw** extension.

You can open these files in the PCIe Protocol Suite application using the **File > Open** command.

Chapter 10

Reports and Tools

Reports assist you in analyzing traffic recorded by the Analyzer. The available reports are:

- **File Information**: To view general information about the CATC Trace file.
- **Error Summary**: To view a count of errors in a CATC Trace file.
- **Traffic Summary**: To view a summary of protocol-related information in the CATC Trace file summary information about a selected group of items in the CATC Trace file (such as a count of particular frame or packet types).
- **Bus Utilization**: To display information on bandwidth usage for the transmit and receive channels.
- **Link Tracker**: Displays a detailed chronological view of events.
- **Data Flow**: Shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information.
- **Trace Navigator**: Navigates within the CATC Trace to view the location of errors and triggers, narrow the range of traffic on display, and jump to any point in the CATC Trace.
- **Detail View**: Shows the detail view of the selected packet.
- **LTSSM Flow Graph**: Shows a state diagram of bus activity.
- **Packet Header**: Shows packet header information
- **Packet Data**: Shows packet or transaction payload.
- **Configuration Space**: Displays a Configuration Space.
- **Metrics**: Measures key operating parameters.
- **TC to VC Mapping**: To display how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions).
- **Timing Calculations**: To view timing measured between two events set within the CATC Trace file.
- **NVMe Base Address Mapping:** Presents the dialog for the NVMe HCI Base Address. This dialog displays the Device ID and whether or not the device is NVMe.
- **Run Verification Scripts**: Allows you to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs.
- **Trace Expert**: Generates reports on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information. See "Trace Expert" on page 274.

Reports are available from the Report menu and buttons on the Tool bar. Tools are available from the Tools menu.

10.1 Trace Information

The Trace Information window provides a summary on the currently displayed file.

Select **Report > Trace Information** to obtain the Trace Information window.

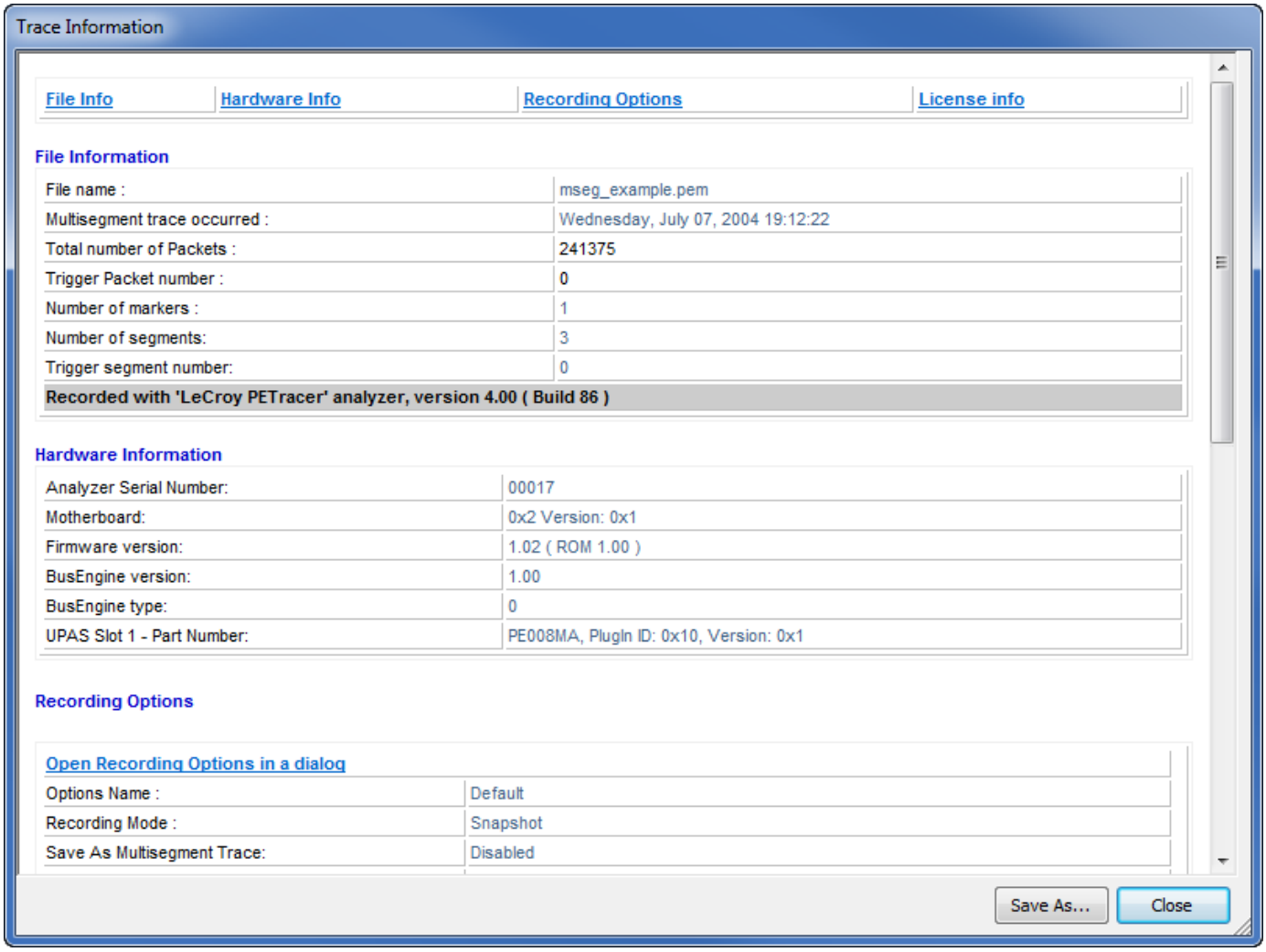
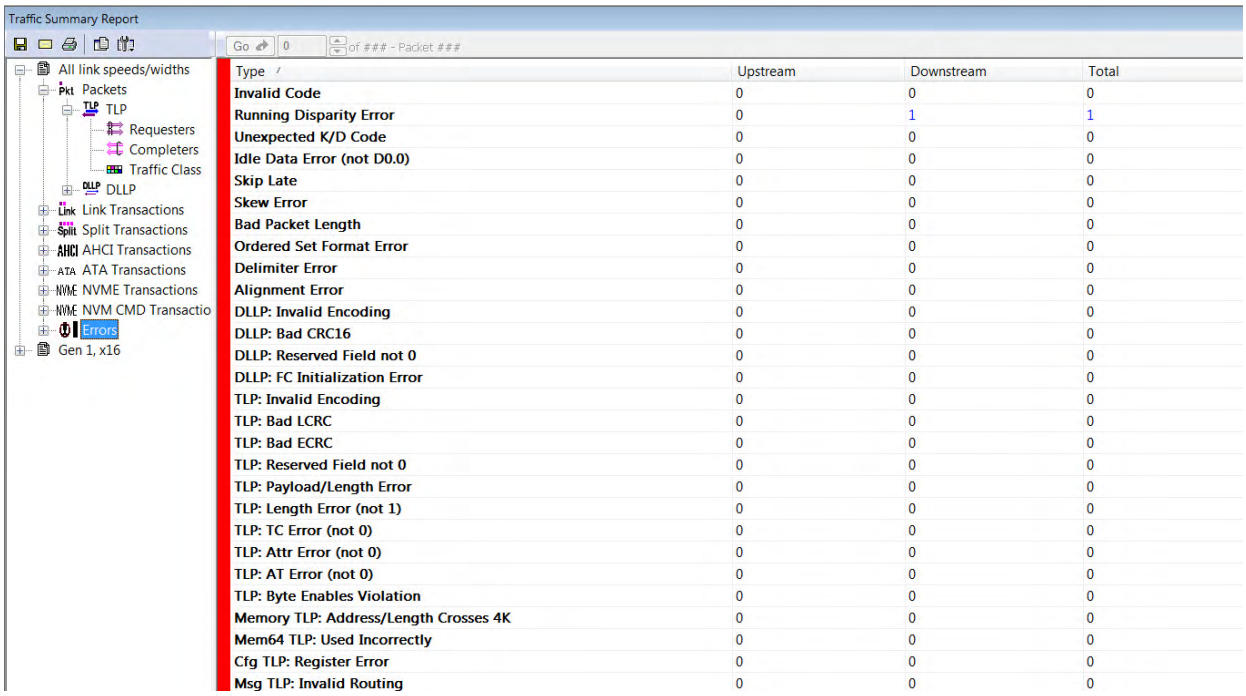

Trace Information
File Info
Hardware Info
Recording Options
License info
File Information
File name : mseg_example.pem
Multisegment trace occurred : Wednesday, July 07, 2004 19:12:22
Total number of Packets : 241375
Trigger Packet number : 0
Number of markers : 1
Number of segments: 3
Trigger segment number: 0
Recorded with 'LeCroy PETracer' analyzer, version 4.00 (Build 86)
Hardware Information
Analyzer Serial Number: 00017
Motherboard: 0x2 Version: 0x1
Firmware version: 1.02 (ROM 1.00)
BusEngine version: 1.00
BusEngine type: 0
UPAS Slot 1 - Part Number: PE008MA, PlugIn ID: 0x10, Version: 0x1
Recording Options
Open Recording Options in a dialog
Options Name : Default
Recording Mode : Snapshot
Save As Multisegment Trace: Disabled
Save As...
Close

Figure 10.1: Trace Information Window

10.2 Error Summary

The Error Summary dialog displays the number of errors for each event and the packet containing the errors.

Select **Reports > Error Summary** to open the Error Summary dialog (see Figure 10.2 on page 209).



Type	Upstream	Downstream	Total
Invalid Code	0	0	0
Running Disparity Error	0	1	1
Unexpected K/D Code	0	0	0
Idle Data Error (not D0.0)	0	0	0
Skip Late	0	0	0
Skew Error	0	0	0
Bad Packet Length	0	0	0
Ordered Set Format Error	0	0	0
Delimiter Error	0	0	0
Alignment Error	0	0	0
DLLP: Invalid Encoding	0	0	0
DLLP: Bad CRC16	0	0	0
DLLP: Reserved Field not 0	0	0	0
DLLP: FC Initialization Error	0	0	0
TLP: Invalid Encoding	0	0	0
TLP: Bad LCRC	0	0	0
TLP: Bad ECRC	0	0	0
TLP: Reserved Field not 0	0	0	0
TLP: Payload/Length Error	0	0	0
TLP: Length Error (not 1)	0	0	0
TLP: TC Error (not 0)	0	0	0
TLP: Attr Error (not 0)	0	0	0
TLP: AT Error (not 0)	0	0	0
TLP: Byte Enables Violation	0	0	0
Memory TLP: Address/Length Crosses 4K	0	0	0
Mem64 TLP: Used Incorrectly	0	0	0
Cfg TLP: Register Error	0	0	0
Msg TLP: Invalid Routing	0	0	0

Figure 10.2: Error Summary Dialog

10.2.1 Error Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the errors found for the trace. Example: The AHCI Error Summary dialog is a sub-entry for the main Error Summary dialog. It displays the number of errors for each AHCI transaction containing the errors.

Select **Reports > Error Summary** to open the Error Summary dialog.

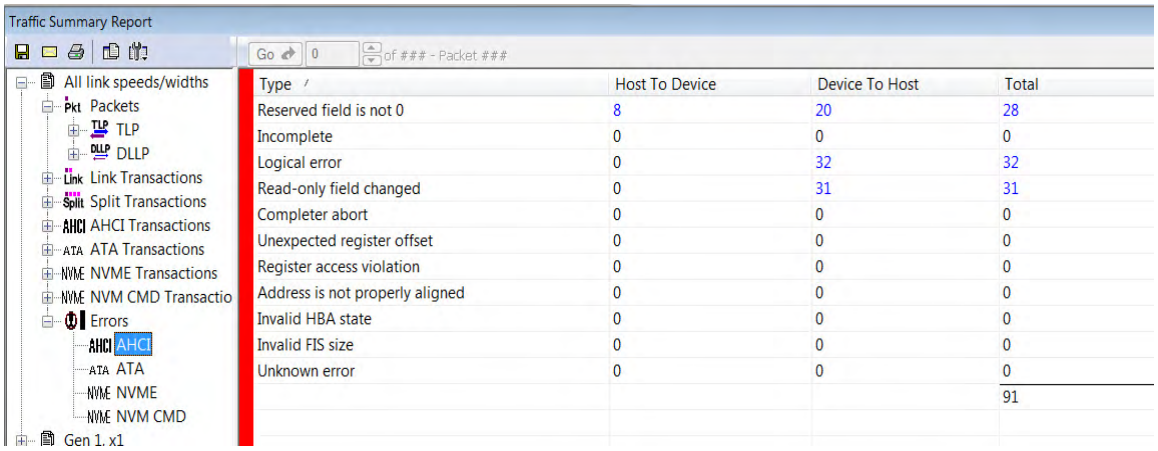


Figure 10.3: AHCI Error Summary Dialog

The five types of AHCI errors are describe below:

Reserved Field not Zeroes

One or more fields inside the AHCI transaction are not filled with all 0s. The AHCI specification states that all reserved fields and registers must be filled with 0s (see Figure 10.4 on page 210).

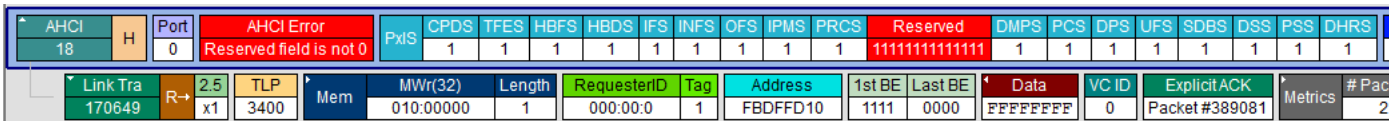


Figure 10.4: Reserved Field Not Filled With Zeroes

Note: Reserved fields for AHCI level are not displayed when filled with all 0s.

Incomplete

The AHCI transaction does not contain enough data or lower-level transactions (Link or Split) are marked as incomplete.

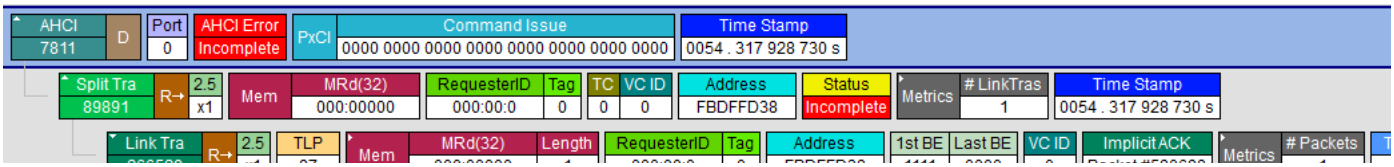


Figure 10.5: Incomplete

Logical Error

One or more fields are in an inconsistent state relative to the other fields in the same or other registers.

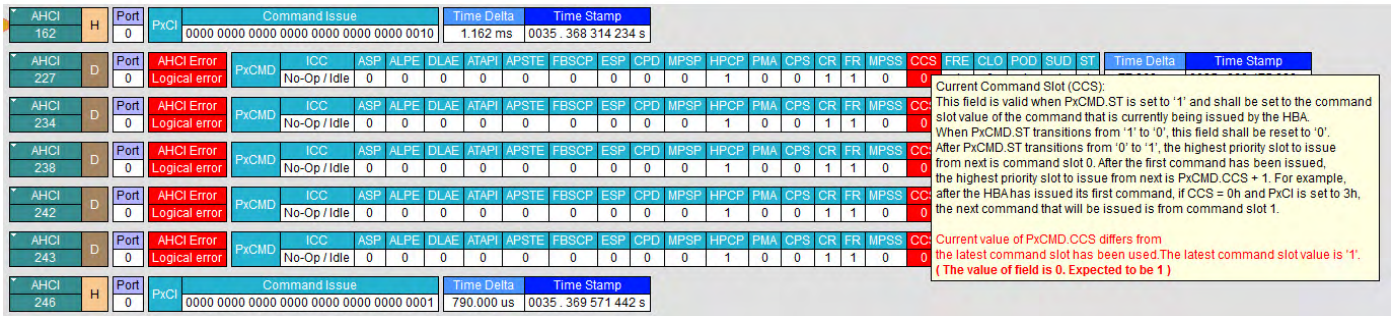

AHCI
162
H
Port
0
PxCI
Command Issue
0000 0000 0000 0000 0000 0000 0000 0010
Time Delta
1.162 ms
Time Stamp
0035 . 368 314 234 s
AHCI
227
D
AHCI Error
Logical error
PxCMD
ICC
No-Op / Idle
ASP ALPE DLAE ATAPI APSTE FBSCP ESP CPD MPSP HPCP PMA CPS CR FR MPSS CCS
FRE CLO POD SUD ST
Time Delta
Time Stamp
AHCI
234
AHCI
238
AHCI
242
AHCI
243
AHCI
246
0000 0000 0000 0000 0000 0000 0000 0001
790.000 us
0035 . 369 571 442 s
Current Command Slot (CCS):
This field is valid when PxCMD.ST is set to '1' and shall be set to the command slot value of the command that is currently being issued by the HBA.
When PxCMD.ST transitions from '1' to '0', this field shall be reset to '0'.
After PxCMD.ST transitions from '0' to '1', the highest priority slot to issue from next is command slot 0. After the first command has been issued, the highest priority slot to issue from next is PxCMD.CCS + 1. For example, after the HBA has issued its first command, if CCS = 0h and PxCI is set to 3h, the next command that will be issued is from command slot 1.
Current value of PxCMD.CCS differs from the latest command slot has been used.The latest command slot value is '1'.
(The value of field is 0. Expected to be 1)

Figure 10.6: Logical Error

Read-only Field Changed

The value of the read-only field differs from the previous one.

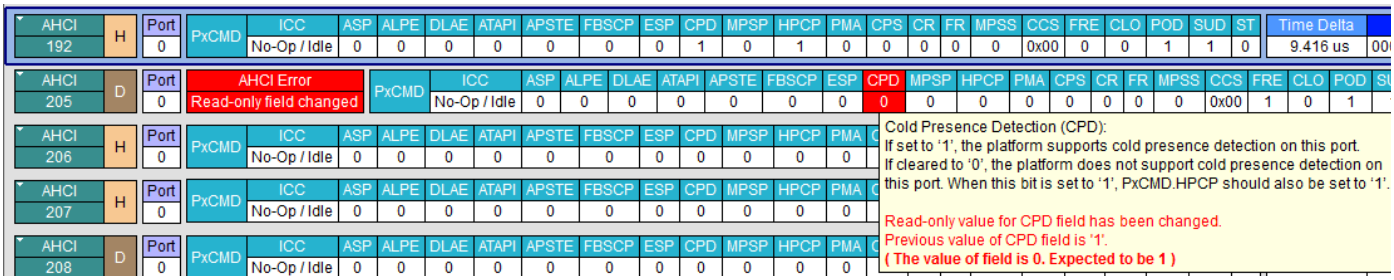

AHCI
192
H
Port
0
PxCMD
ICC
No-Op / Idle
ASP ALPE DLAE ATAPI APSTE FBSCP ESP CPD MPSP HPCP PMA CPS CR FR MPSS CCS FRE CLO POD SUD ST
Time Delta
9.416 us
AHCI
205
D
AHCI Error
Read-only field changed
AHCI
206
H
AHCI
207
H
AHCI
208
D
Cold Presence Detection (CPD):
If set to '1', the platform supports cold presence detection on this port.
If cleared to '0', the platform does not support cold presence detection on this port. When this bit is set to '1', PxCMD.HPCP should also be set to '1'.
Read-only value for CPD field has been changed.
Previous value of CPD field is '1'.
(The value of field is 0. Expected to be 1)

Figure 10.7: Read-only Field Changed

Unknown

The AHCI decoder is unable to decode a particular transaction correctly. This can be caused by a distorted trace file. This can be caused by missing base address information.

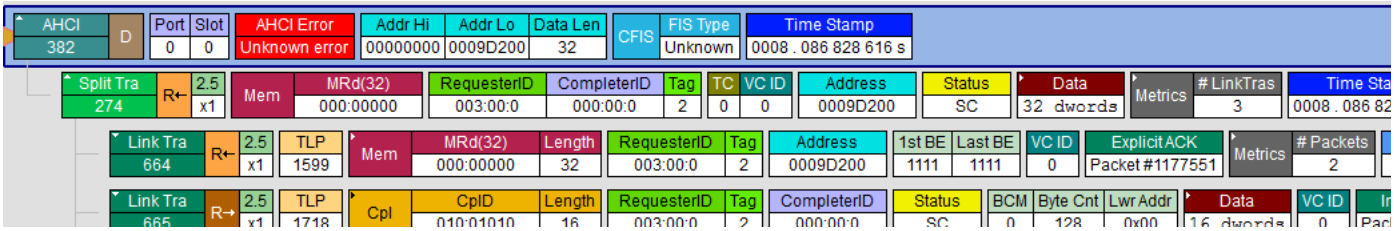


Figure 10.8: Unknown

Checks for Logical error and Read-only field depending on the values obtained from previous registers. It can result in false-positive or false-negative detections in case of

partially saved trace file. The AHCI transaction can be marked as incomplete in case of saving a portion.

10.2.2 Error Summary for Storage Protocols -- NVMe

The NVMe sub-entry of the Error Summary dialog displays the number of NVMe errors found while decoding the trace at the NVMe level as shown in Figure 10.9, Figure 10.10 and Figure 10.11.

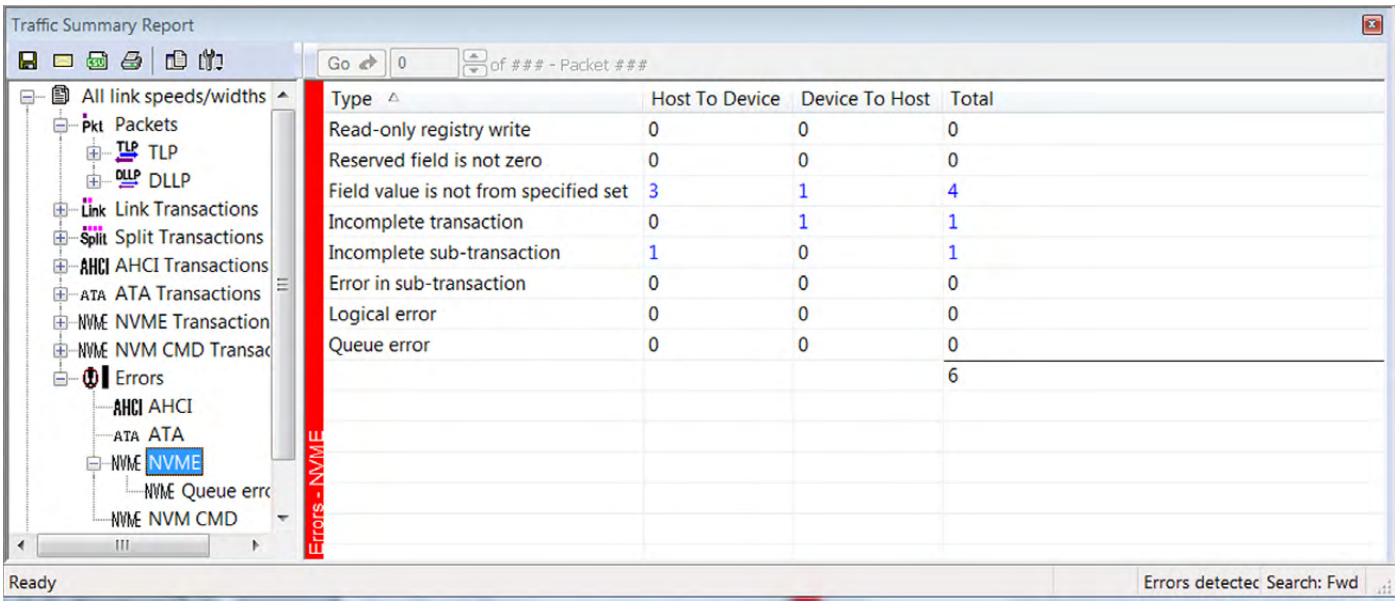


Figure 10.9: NVMe Errors After Decoding the Trace

The NVMe Queue Error sub-entry of the Error Summary dialog lists NVMe errors which are specific to interacting with the NVMe queues.

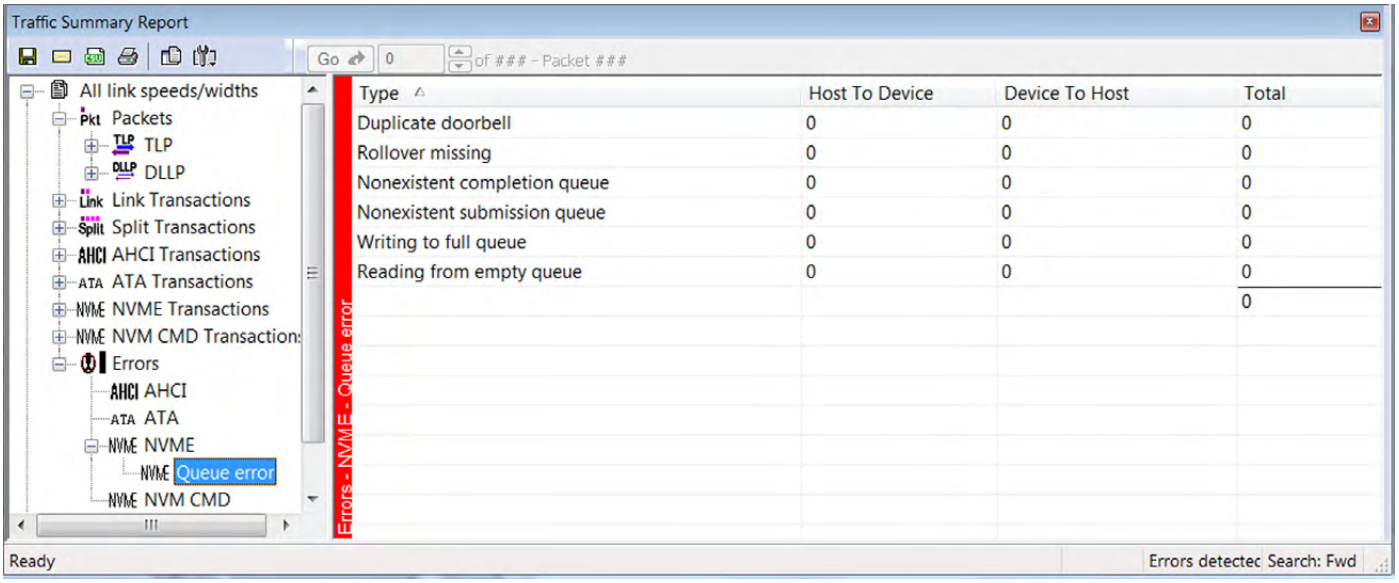


Figure 10.10: NVMe Errors Specific to NVMe Queues

The NVMe CMD sub-entry of the Error Summary dialog lists errors which are specific to NVMe command decoding. See Figure 10.11

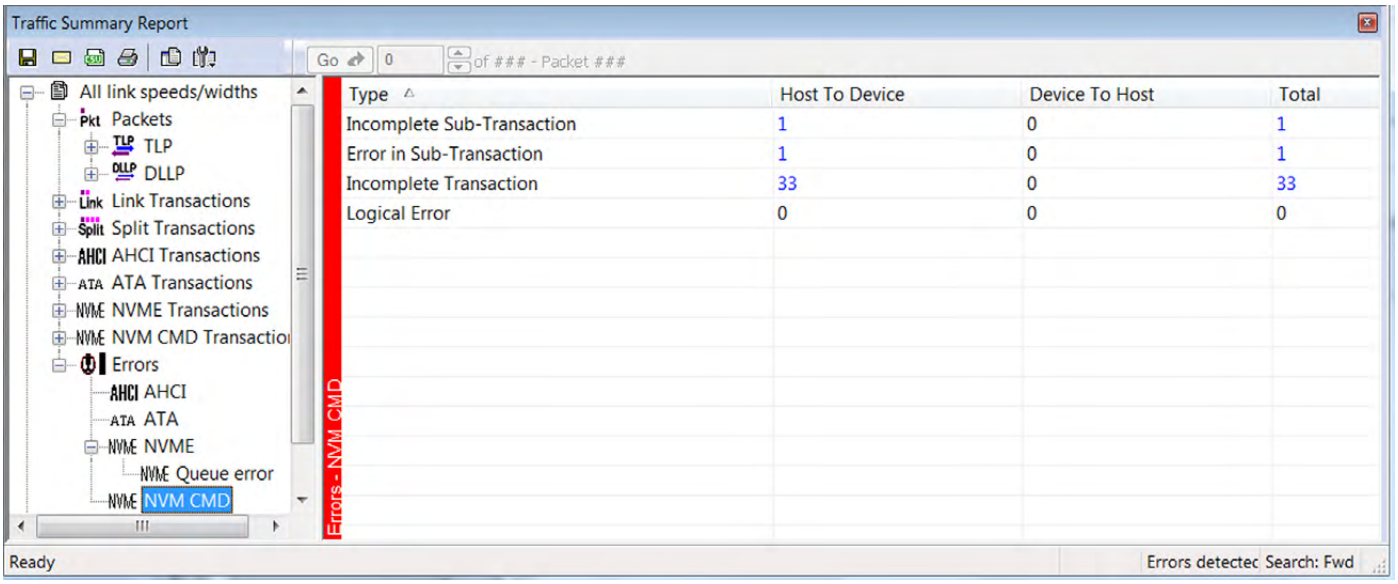
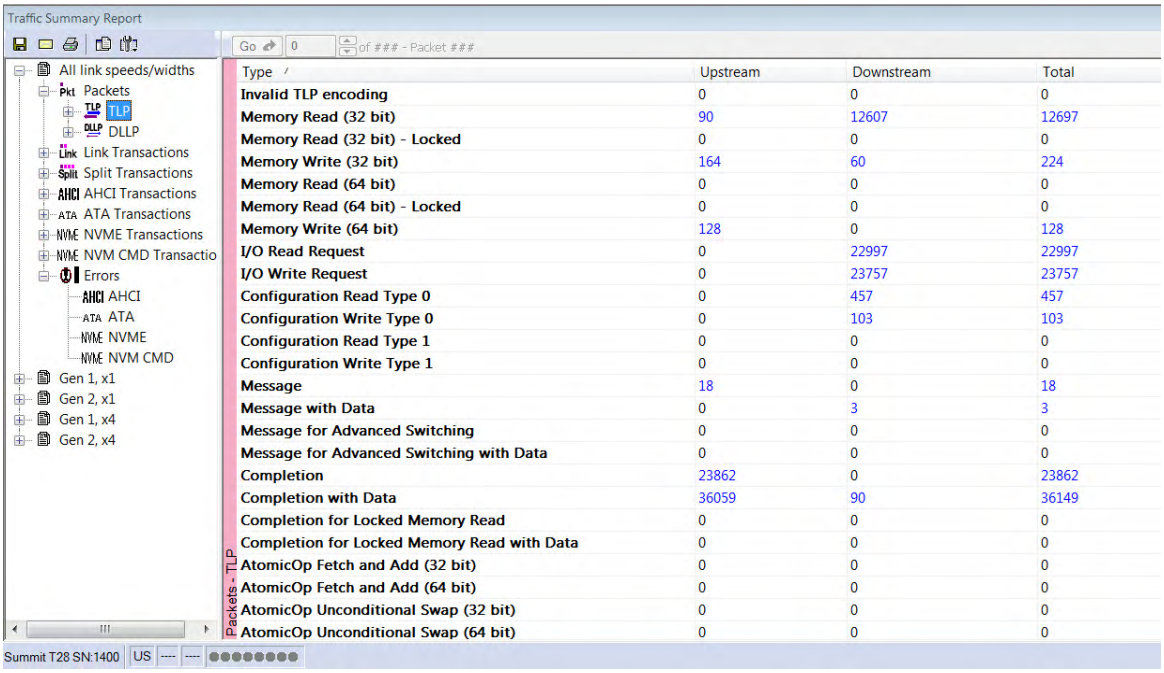


Figure 10.11: NVMe Errors Specific to NVMe Commands

10.3 Traffic Summary

The Traffic Summary window summarizes the traffic in the current CATC Trace. The left side of the window displays a tree of protocol levels. The right side displays a summary of traffic for the displayed levels.

Select **Reports > Traffic Summary** or click to display the Traffic Summary window (see Figure 10.12 on page 214).



Type	Upstream	Downstream	Total
Invalid TLP encoding	0	0	0
Memory Read (32 bit)	90	12607	12697
Memory Read (32 bit) - Locked	0	0	0
Memory Write (32 bit)	164	60	224
Memory Read (64 bit)	0	0	0
Memory Read (64 bit) - Locked	0	0	0
Memory Write (64 bit)	128	0	128
I/O Read Request	0	22997	22997
I/O Write Request	0	23757	23757
Configuration Read Type 0	0	457	457
Configuration Write Type 0	0	103	103
Configuration Read Type 1	0	0	0
Configuration Write Type 1	0	0	0
Message	18	0	18
Message with Data	0	3	3
Message for Advanced Switching	0	0	0
Message for Advanced Switching with Data	0	0	0
Completion	23862	0	23862
Completion with Data	36059	90	36149
Completion for Locked Memory Read	0	0	0
Completion for Locked Memory Read with Data	0	0	0
AtomicOp Fetch and Add (32 bit)	0	0	0
AtomicOp Fetch and Add (64 bit)	0	0	0
AtomicOp Unconditional Swap (32 bit)	0	0	0
AtomicOp Unconditional Swap (64 bit)	0	0	0

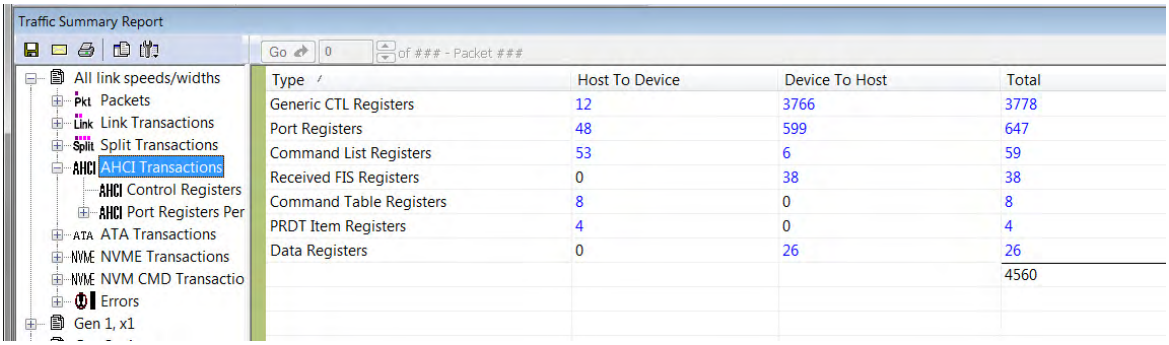
Figure 10.12: Traffic Summary Dialog

Buttons at the top of the Traffic Summary window change the display format and enable data to be exported to email, file, or the printer.

10.3.1 Traffic Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the commands existing in the trace. Example: The AHCI Traffic Summary window summarizes the AHCI traffic in the current CATC Trace. The right side displays a summary of AHCI transactions and errors.

Select **Reports > Traffic Summary** to open the Traffic Summary dialog.



Type	Host To Device	Device To Host	Total
Generic CTL Registers	12	3766	3778
Port Registers	48	599	647
Command List Registers	53	6	59
Received FIS Registers	0	38	38
Command Table Registers	8	0	8
PRDT Item Registers	4	0	4
Data Registers	0	26	26
			4560

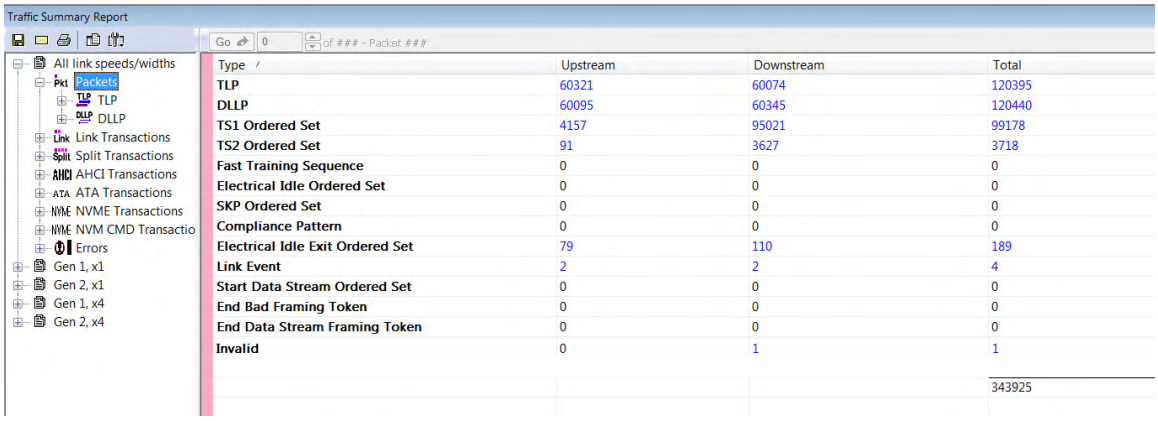
Figure 10.13: AHCI Traffic Summary Dialog

10.3.2 Using the Traffic Summary Window to Search the CATC Trace

You can use the Traffic Summary window to move the CATC Trace to packets of interest:

1. Click one of the numbers in the right side of the Traffic Summary window.

   The CATC Trace jumps to the first instance of the selected protocol (See the following figure).



2. Click the **up** or **down** arrows

. The CATC Trace jumps forward or backward through the display to the next instance of selected protocol level.

10.3.3 NVMe Queue Time Metrics

NVMe Queue Time Metrics can be seen in the Traffic Summary, which includes all of the Doorbell Metrics (see Figure 10.14).

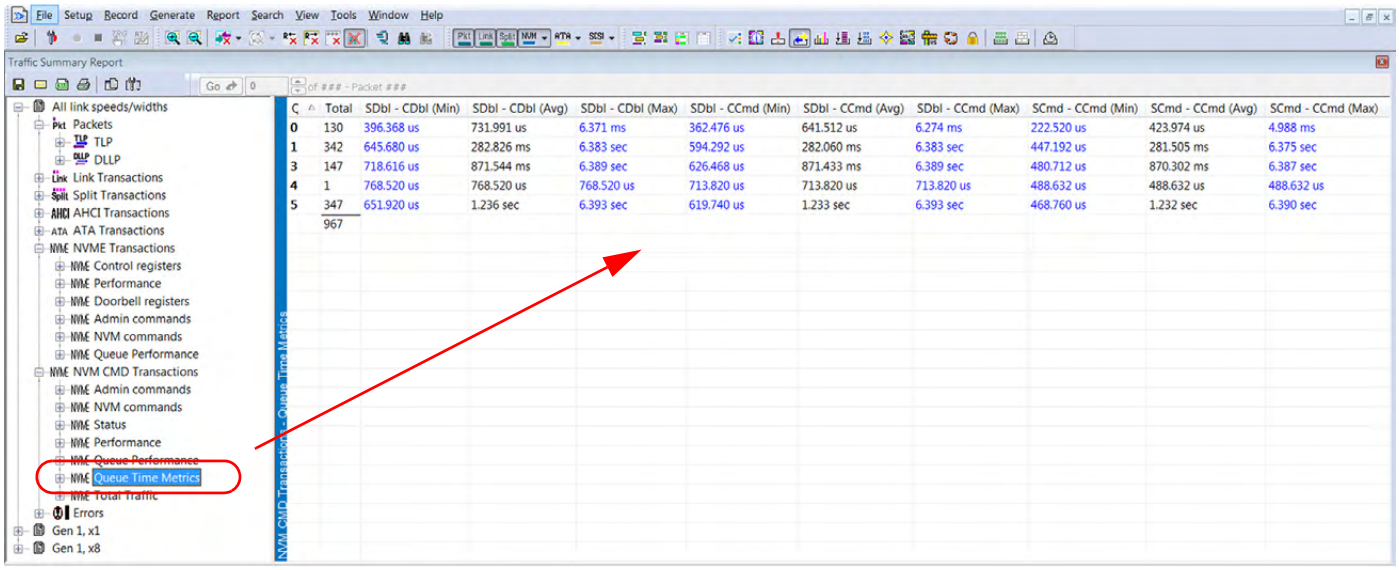

File Setup Record Generate Report Search View Tools Window Help
Traffic Summary Report
All link speeds/widths
Packets
TLP
DLLP
Link Transactions
Split Transactions
AHCI Transactions
ATA Transactions
NVME Transactions
NVME Control registers
NVME Performance
NVME Doorbell registers
NVME Admin commands
NVME NVM commands
NVME Queue Performance
NVM CMD Transactions
NVME Admin commands
NVME NVM commands
NVME Status
NVME Performance
NVME Queue Time Metrics
Errors
Gen 1, x1
Gen 1, x8
NVM CMD Transactions - Queue Time Metrics
C Total SDbl - CDbl (Min) SDbl - CDbl (Avg) SDbl - CDbl (Max) SDbl - CCmd (Min) SDbl - CCmd (Avg) SDbl - CCmd (Max) SCmd - CCmd (Min) SCmd - CCmd (Avg) SCmd - CCmd (Max)
0 130 396.368 us 731.991 us 6.371 ms 362.476 us 641.512 us 6.274 ms 222.520 us 423.974 us 4.988 ms
1 342 645.680 us 282.826 ms 6.383 sec 594.292 us 282.060 ms 6.383 sec 447.192 us 281.505 ms 6.375 sec
3 147 718.616 us 871.544 ms 6.389 sec 626.468 us 871.433 ms 6.389 sec 480.712 us 870.302 ms 6.387 sec
4 1 768.520 us 768.520 us 768.520 us 713.820 us 713.820 us 713.820 us 488.632 us 488.632 us 488.632 us
5 347 651.920 us 1.236 sec 6.393 sec 619.740 us 1.233 sec 6.393 sec 468.760 us 1.232 sec 6.390 sec
967

Figure 10.14: NVMe Queue Time Metrics for Doorbell Operations

10.3.4 Traffic Summary Buttons

Buttons at the top of the Traffic Summary dialog provide options for exporting the data or formatting its appearance:

	Save. Saves Traffic Summary results into an HTML format.
	Email. Attaches an HTML file of the results to a new email.
	Print. Prints results.
	Text. Displays results in HTML format.
	Options. Opens a drop-down menu with the following options: **Grid Lines**: Displays/Hides grid lines **Row Selection**: Allows entire rows to be selected **Tight Columns**: Reformats column widths to match data **Event Navigation**: Skip Hidden Items Show Hidden Items Prompt each time

10.4 Bus Utilization

Select **Report > Bus Utilization** from the menu or press to open the Bus Utilization window.

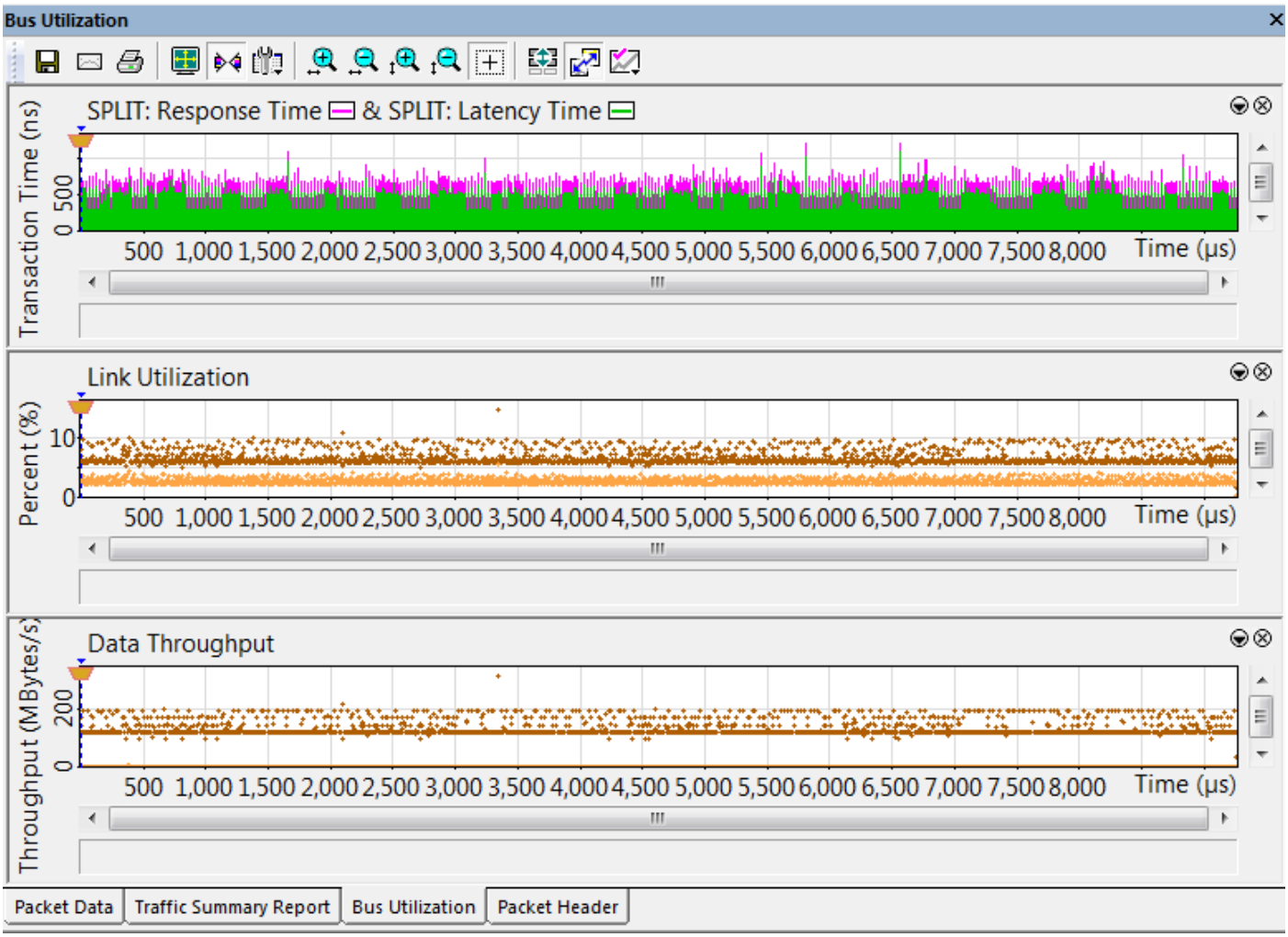
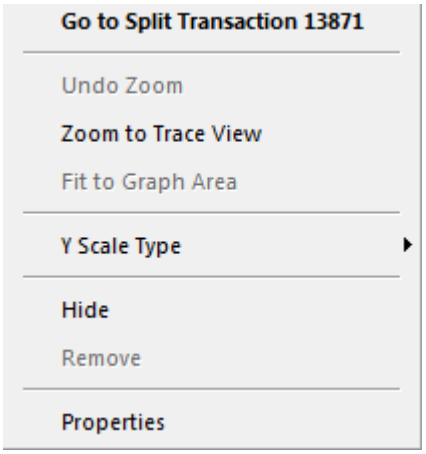


Figure 10.15: Bus Utilization Window

The Bus Utilization window displays information on bandwidth use for the transmit and receive channels.

10.4.1 Bus Utilization Pop-up Menu

You can reformat the display by right-clicking a graph and making a selection from the Bus Utilization pop-up menu (see the following figure).



Go to Packet #: Relocates the CATC Trace to the selected packet number.

Undo Zoom: If you have zoomed in, this command undoes the zoom.

Zoom to Trace View: Zooms in on graph to show traffic currently displayed in the CATC Trace screen.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format
- **Logarithmic**: Converts display to logarithmic format

Hide: Hides the selected graph

Remove: Allows you to remove any graph that you created via the **New** command

Properties: Opens a dialog with options for changing the Title, Type, Appearance, and Color of the graphs (see Figure 10.16 on page 219).

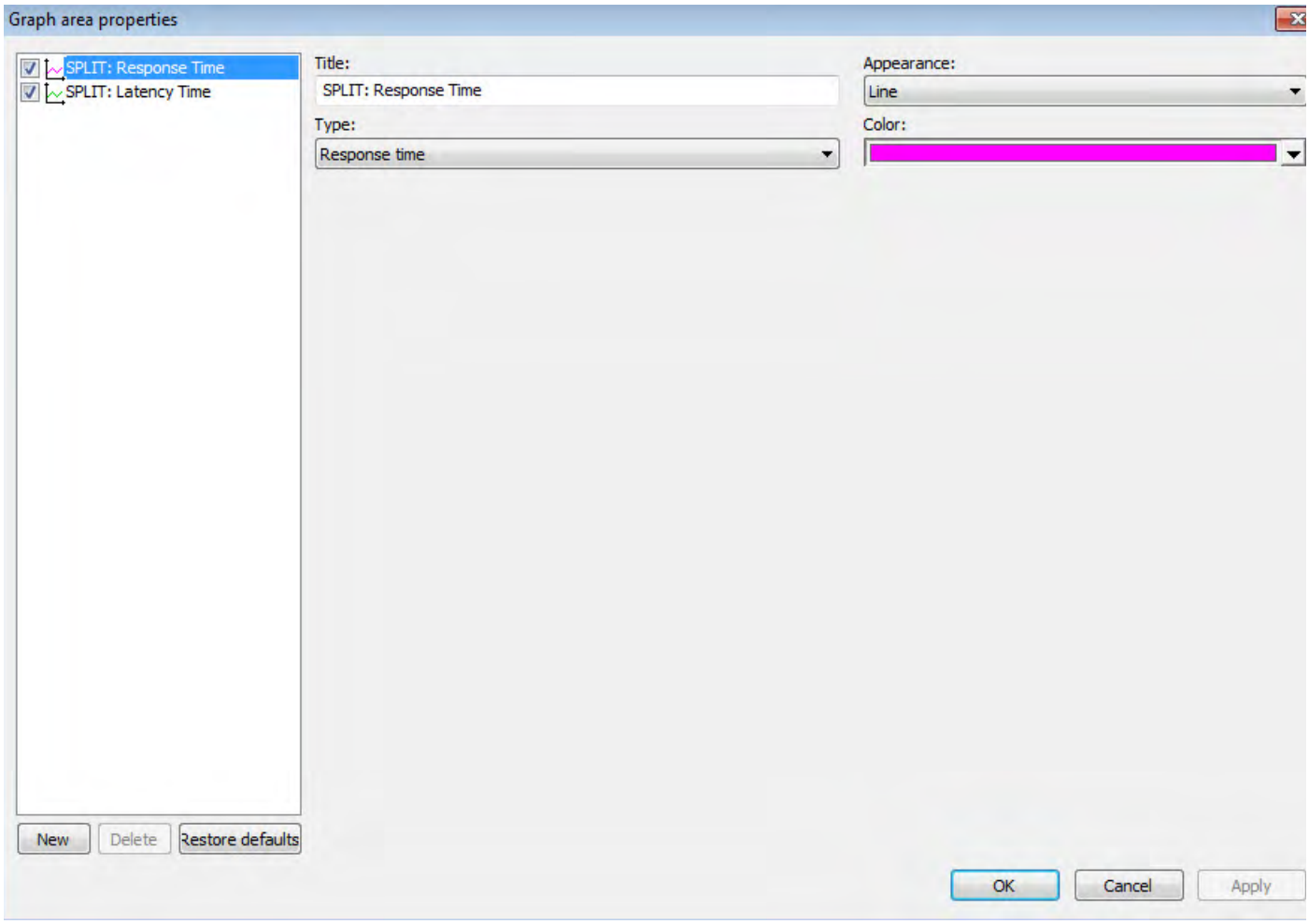


Figure 10.16: Graph Area Properties Dialog

10.4.2 Bus Utilization Buttons

The Bus Utilization window buttons allow you to reformat the display and export data.

Button	Function
	Save. Saves Bus Utilization data to a bitmap file (***.bmp**).
	Email. Opens an email and attaches a bitmap file of the Bus Utilization data.
	Print. Prints the Bus Utilization data.
	Full Screen. Maximizes the Bus Utilization window.
	View Settings. Opens a sub-menu with the following choices: • Orient Horizontally • Tile Vertically • Show Markers • Show Plumbline • Status >> • Bar • Tool tips • None • Grid Lines >> • Both Axes • X Axis • Y Axis • No Grid • Grid on Top • Fonts & Colors
	Horizontal zoom in

	Horizontal zoom out
	Vertical zoom in
	Vertical zoom out
	Click and Drag zoom. Click and drag to zoom in on a part of the graph.
	Select Range. Displays a dialog for selecting a packet range.
	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Provides options for creating and displaying additional graphs of data lengths, packet lengths, and percentage of bus used (see Graph Area Options below).

Graph Area Options

The available graphs are shown in Figure 10.17:

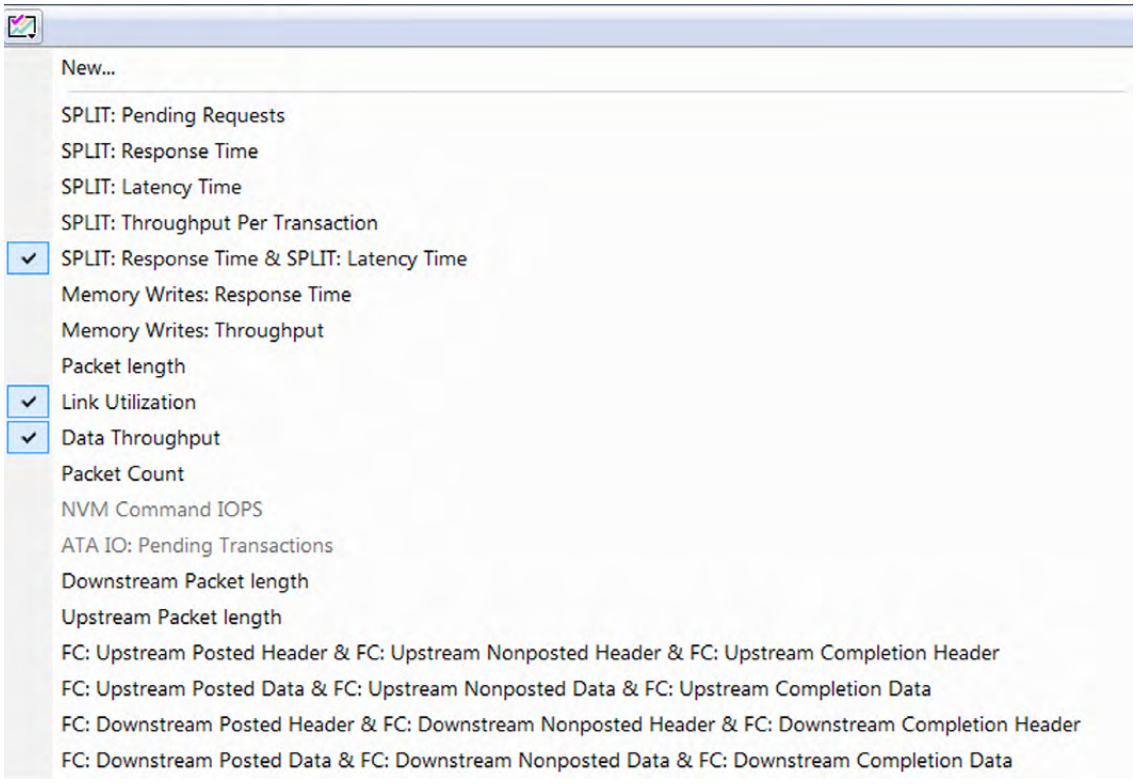

New...
SPLIT: Pending Requests
SPLIT: Response Time
SPLIT: Latency Time
SPLIT: Throughput Per Transaction
SPLIT: Response Time & SPLIT: Latency Time
Memory Writes: Response Time
Memory Writes: Throughput
Packet length
Link Utilization
Data Throughput
Packet Count
NVM Command IOPS
ATA IO: Pending Transactions
Downstream Packet length
Upstream Packet length
FC: Upstream Posted Header & FC: Upstream Nonposted Header & FC: Upstream Completion Header
FC: Upstream Posted Data & FC: Upstream Nonposted Data & FC: Upstream Completion Data
FC: Downstream Posted Header & FC: Downstream Nonposted Header & FC: Downstream Completion Header
FC: Downstream Posted Data & FC: Downstream Nonposted Data & FC: Downstream Completion Data

Figure 10.17: Graph Area Options Dialog

- New - Opens Graph Area Properties dialog to specify a new graph
- SPLIT: Pending Requests
- SPLIT: Response Time
- SPLIT: Latency Time
- SPLIT: Throughput Per Transaction
- SPLIT: Response Time & SPLIT: Latency Time
- Memory Writes: Response Time
- Memory Writes: Throughput
- Packet Length
- Link Utilization
- Data Throughput
- Packet Count
- NVMe Command IOPS
- ATA IO: Pending Transactions
- Downstream Packet Length
- Upstream Packet Length
- FC: Upstream Posted Header & FC: Upstream Nonposted Header FC: Upstream Completion Header
- FC: Upstream Posted Data & FC: Upstream Nonposted Data FC: Upstream Completion Data
- FC: Downstream Posted Header & FC: Downstream Nonposted Header FC: Downstream Completion Header
- FC: Downstream Posted Data & FC: Downstream Nonposted Data FC: Downstream Completion Data

10.5 Link Tracker

The Link Tracker window displays a detailed chronological view of events. Events are shown on a channel-by-channel basis in columns within the window.

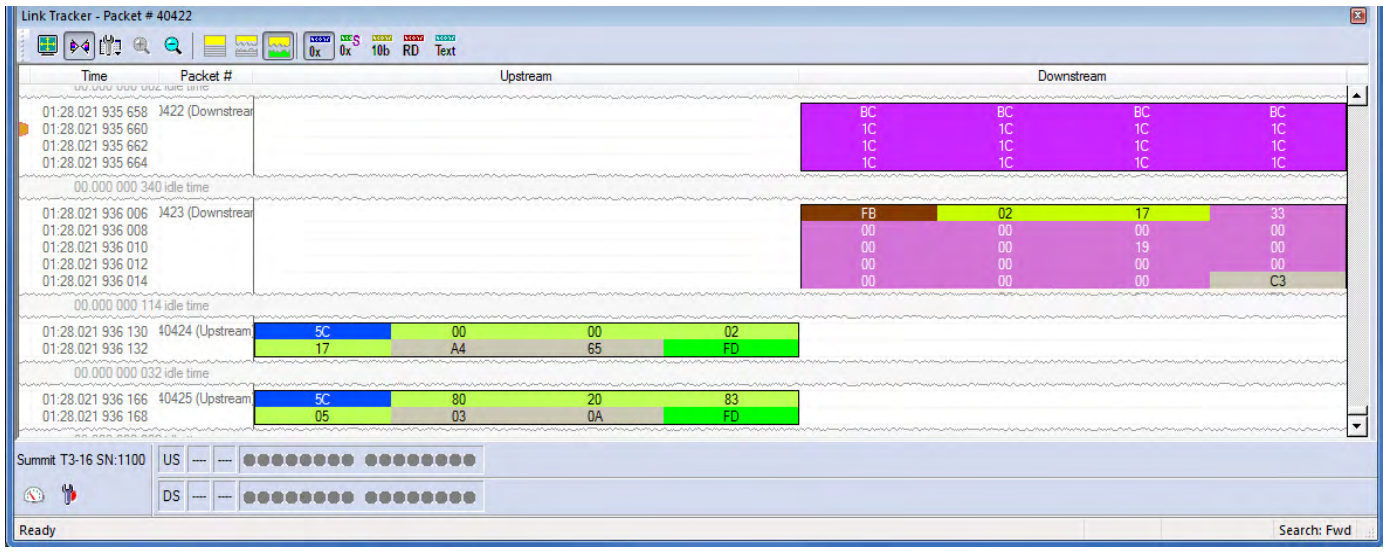


Figure 10.18: Link Tracker Window

Each time slot in the vertical axis represents the minimum time that a DWORD requires to traverse the bus (see the following figure).

Toolbar: Presents buttons for changing the format of the Link Tracker window.

Main Display Area: Displays traffic chronologically as it occurred in the recording. The window divides into columns: the first column shows time and traffic is shown on a channel-by-channel basis in the columns on the right.

10.5.1 Using the Link Tracker Window

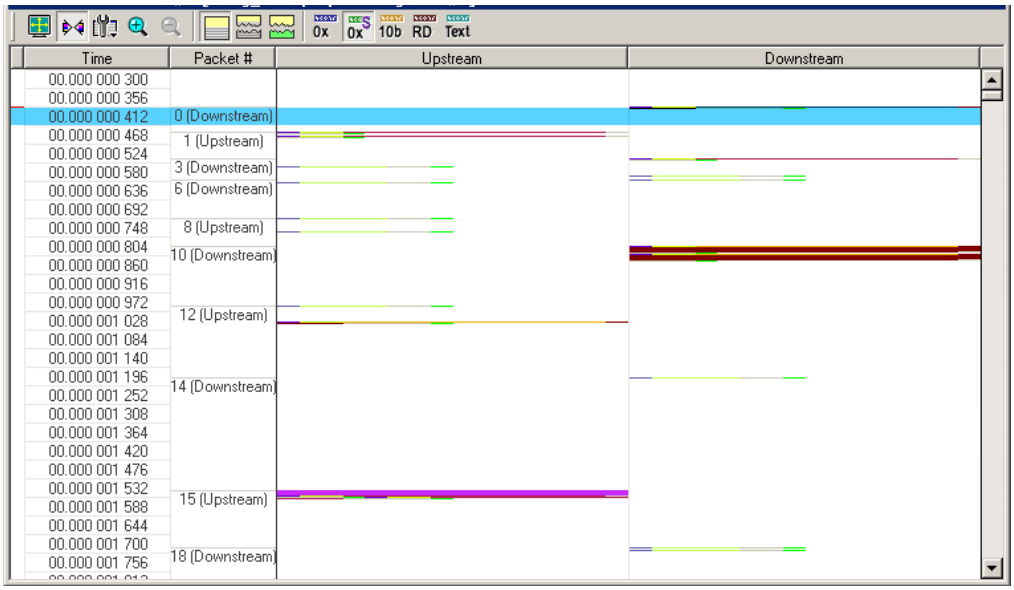
The Link Tracker window can be reformatted in several ways.

10.5.2 Zooming In and Out

Zooming out can give you a quick, high-level view of a CATC Trace (see the following figure). A fully zoomed out CATC Trace only shows columns and colored lines. Using the colors, you can see what types of traffic run through the CATC Trace (see the following figure).

Further information can be obtained on any point of interest in the CATC Trace by positioning your mouse pointer over it. Tool tips provide detailed description of events.

When fully zoomed out, the smallest graphical unit is the DWORD, represented by a single line. Zooming out makes the CATC Trace appear smaller and increases the time scale in the first column.



10.5.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths

Click the **View Options** button to open a menu with options for formatting the display. Three options are presented:

Collapsible Idle Time: Opens a dialog box for setting the Idle time value. Setting a value tells the Analyzer when to collapse Idle times and display them as grayed out strips within the Bus View window.

Tooltip Display: Opens a menu with options for adding content to Tooltips. Tooltips display when you position the mouse pointer over an item in the Bus View window. The options are:

- Tooltips Display Values
- Tooltips Display Scrambled Values
- Tooltips Display 10-bit Codes
- Tooltips Display Symbols

Time Format: Seconds or Clock

Reset Column Widths: This option resets column widths to their defaults and enables columns to resize themselves automatically any time the application window is resized. Normally, columns automatically resize themselves if the application window is made larger or smaller. However, if you manually resize any columns in the Bus View window, column widths become static. Thereafter, if you resize the application window, the Bus View columns do not adjust automatically. Reset Column Widths re-enables the automatic resizing capability.

Reset Columns Order: Return to default column sequence.

10.5.4 Docking and Undocking the Window

You can undock the Link Tracker window by double-clicking the blue title bar along the left side of the window. Once undocked, the window can be dragged anywhere in the application. To redock, double-click again on the title bar.

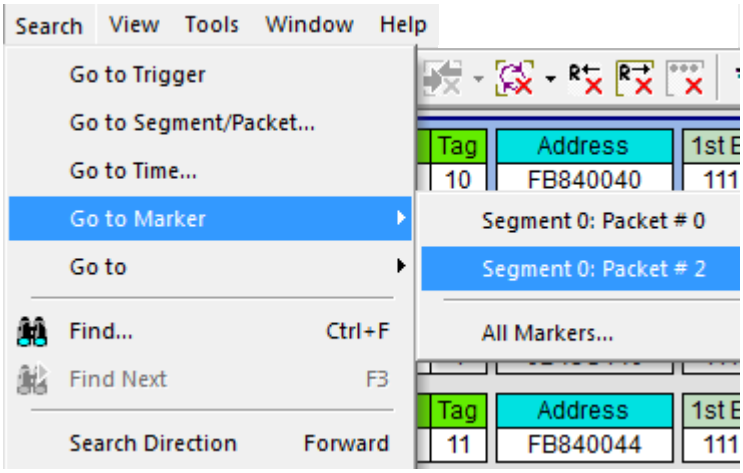
10.5.5 Setting Markers

Markers can be set on any event within the Link Tracker window.

To set a marker, right-click an event, then select **Set Marker** from the pop-up menu.

Once marked, you can navigate to events with the **Go to Marker** command in the Search menu.

Markers set in the Link Tracker window display the packet number and DWORD number. In contrast, markers set in the CATC Trace window just show the packet number.



10.5.6 Calculating Time between DWORDs

You can calculate time between DWORDs by clicking an event and then positioning your mouse pointer over a second event and reading the ensuing Tool tip.

Click the **time value** for the first event. Scroll down through the CATC Trace to the second event and position the mouse pointer above its time value. A Tool tip appears showing the time interval between the first and second events.

10.5.7 Hiding Traffic

You can hide Idles and other data from the Link Tracker window by clicking the **Hide** buttons on the toolbar.

10.5.8 Link Tracker Buttons

The Link Tracker window has a row of buttons for changing the format of the displayed data and for exporting data: The buttons have the following functions:

	Full Screen. Expands the Link Tracker window to fill the entire screen.
	View Options. Opens a menu with three options: • **Collapsible Idle Time** (Collapse Idle Bigger Than **n** nanoseconds. **Note:** Does not affect Collapse Idle Plus.) • **Tooltip Display** (Values, Scrambled Values, 10-bit Codes, Symbols) • **Time Format** (Seconds, Clock) • **Reset Columns Widths** (return to default widths) • **Reset Columns Order** (return to default column sequence) See "Using the Link Tracker Window" on page 223 for further details.
	Synchronize Trace View. Synchronizes the Trace View and Link Tracker windows so that a move in one window repositions the other. Because of the differences in scale and logic between the Link Tracker and Trace view window, scrolling produces different effects depending on which window is being scrolled. Scrolling in the CATC Trace window causes the Link Tracker window to rapidly jump from event to event. Long periods of idle time are thus skipped. Scrolling in the Link Tracker window, in contrast, produces modest movements within the CATC Trace window. Scrolling in the Link Tracker window causes the CATC Trace window to pause until the beginning of a packet is displayed. At that point, the CATC Trace window repositions itself. While scrolling long Idle periods or through the contents of a packet, the CATC Trace window does not move.

	Zoom In
	Zoom Out
	Continuous Time Scale. No collapsing.
	Collapse Idle. Do not show some periods of Link being idle.
	Collapse Idle Plus. Do not show periods of Link being idle.
	Show Values
	Show Scrambled Values
	Show 10b Codes
	Show Symbols
	Show Text

10.6 Data Flow Window

The Data Flow window shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information.

To display the Data Flow window (see Figure 10.19 on page 228), select **Report > Data Flow**

or click the Data Flow toolbar icon.

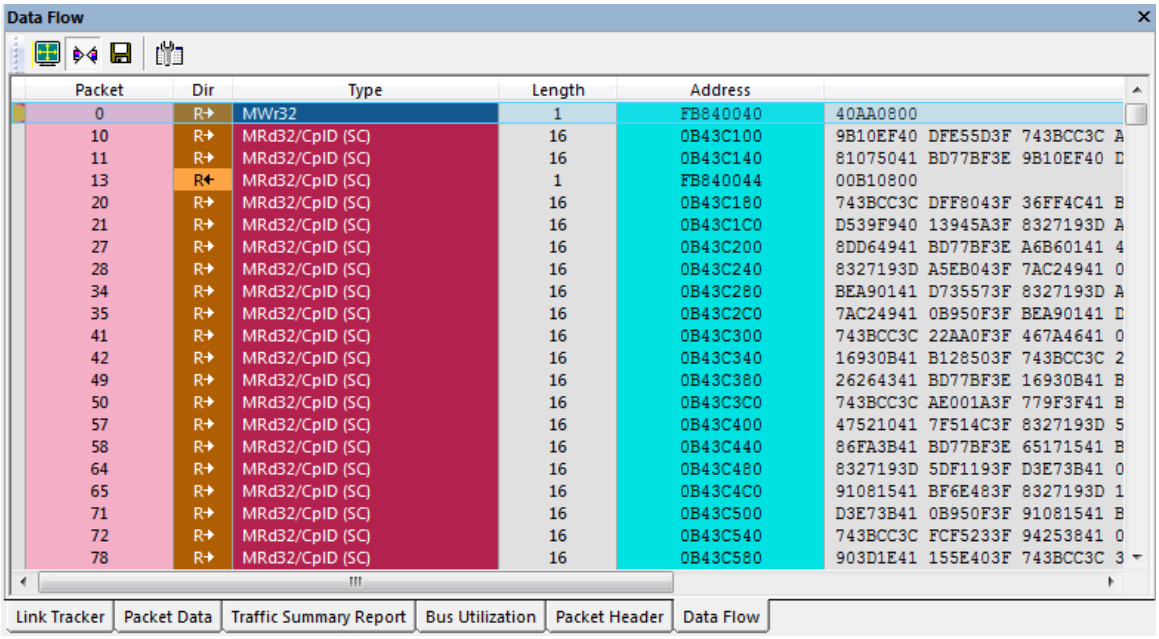


Figure 10.19: Data Flow Window

The toolbar allows you to:

- Expand the window to full screen or Collapse to a smaller window.
- Synchronize.
- Save.
- Select Data Flow columns to display and their widths:
  - Marker
  - Packet
  - Direction
  - Type
  - Length
  - Address
  - Payload
  - Handshake
  - Time Stamp

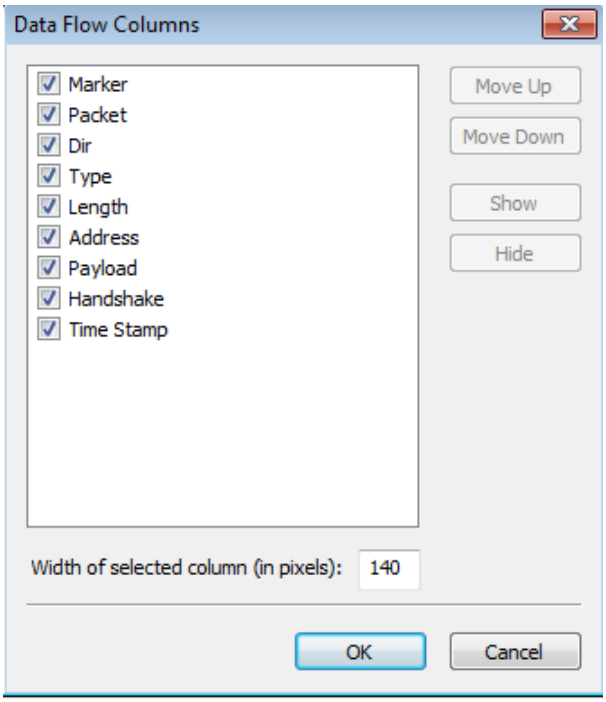


Figure 10.20: Data Flow Columns Dialog

10.7 Flow Control Tracking

The Flow Control View mode highlights portions of the packets that affect flow control and displays flow control values. Flow control values shown at the beginning of Link Transaction display the credit values that were available prior to TLP transmission. Flow control values shown at the end of the Link Transaction display the credit values that were available after TLP was transmitted. Hover the mouse over the field to display tool-tips.

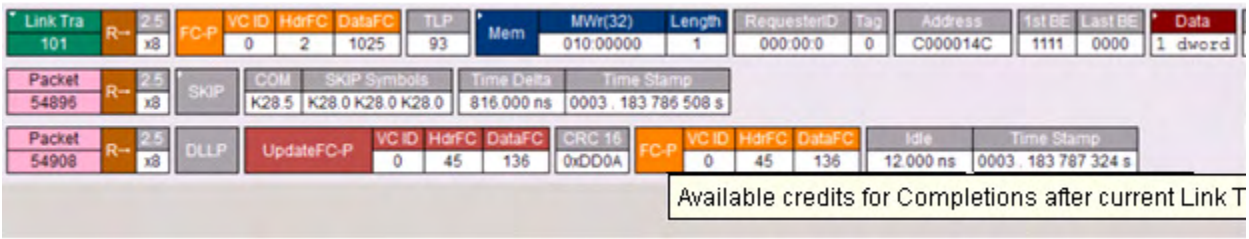


Figure 10.21: Flow Control Display

If the trace includes Flow Control initialization, PCIe Protocol Suite detects the amount of available credits based on the values advertised in InitFC packets. If the InitFC packets are not in the trace, the amount of available credits can be set using the FC Credit Setup dialog (see the following screen capture). Select **View > FC Credits Setup...** displays the FC Credit Setup dialog (see the following screen capture).

For each virtual channel that is present in the trace you need to specify the amount of available credits before the beginning of the trace. You can also specify the values of credit fields for UpdateFC packets before the beginning of the trace. If the values of the

UpdateFC credit fields are different than the values in the first UpdateFC packet, Flow Control tracking view will show that the first UpdateFC packet is releasing appropriate amount of credits. By default, PCIe Protocol Suite sets these values to match the first UpdateFC packets in the trace.

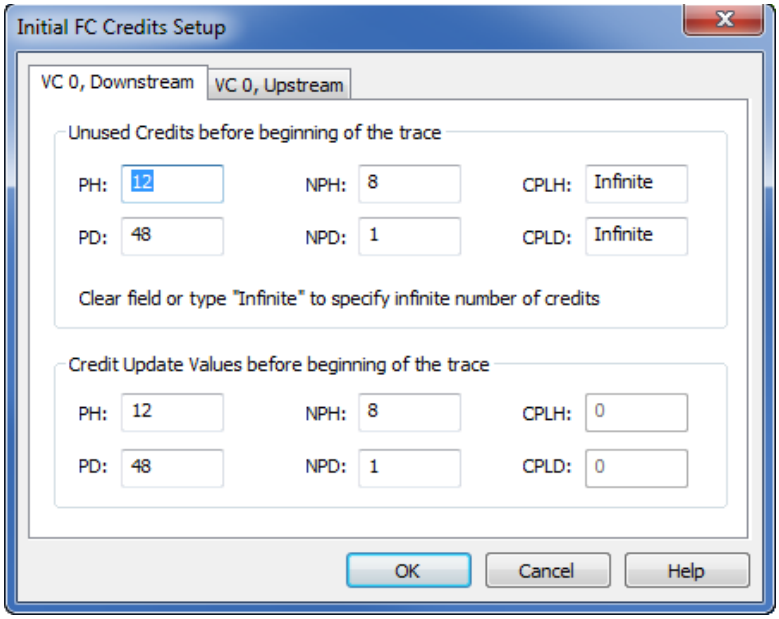


Figure 10.22: Flow Control Setup Dialog

10.8 Using the CATC Trace Navigator

The CATC Trace Navigator is a tool for navigating within the CATC Trace. It allows you to view the location of errors and triggers in a CATC Trace and to narrow the range of traffic on display. It also allows you to quickly jump to any point in the CATC Trace.

10.8.1 Displaying the Navigator

Click in the toolbar to display the Navigator (see Figure 10.23 on page 231). The Navigator appears on the right side of the Main window. It has a two-button toolbar and a vertical slider bar. It also has colored panes for navigating the CATC Trace in different ways. You set which panes are displayed through Navigator pop-up menus.

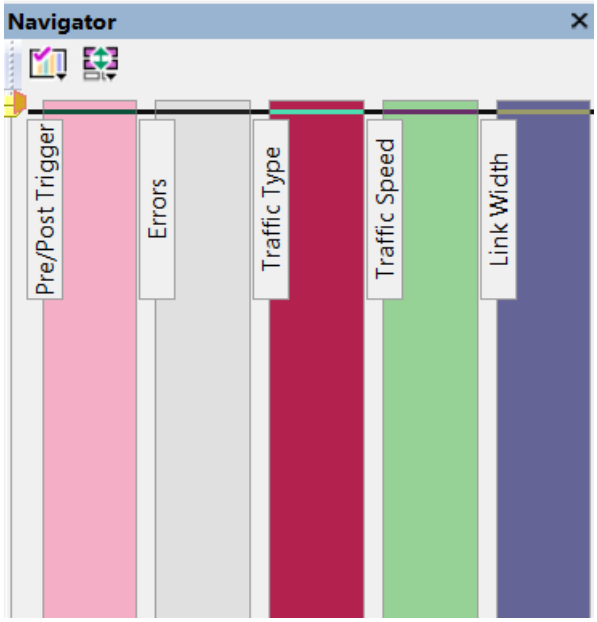


Figure 10.23: Navigator Dialog

10.8.2 Navigator Toolbar

The Navigator toolbar lets you quickly set Navigator features. The toolbar has two buttons.

Navigator Ranges: This button brings up a pop-up menu that lets you reset the Navigator range. The range determines what packets are viewable in the CATC Trace display.

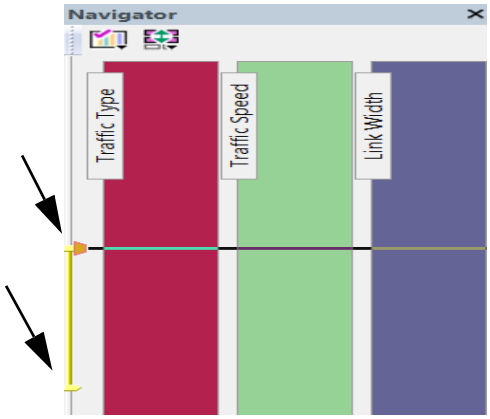
Navigator Panes: This button has two purposes: To select which Navigator panes appear and to bring up the Navigator legend. The legend determines how information is shown in the panes.

10.8.3 Navigator Ranges

You set the viewing range by dragging the **yellow range delimiters** along the slider. To set the lowest packet viewable, drag the **top delimiter up**. As you do so, a tool tip appears to indicate the current range. Stop dragging when you reach the desired lowest packet.

To set the highest packet viewable, drag the **bottom delimiter down**. Stop when the tool tip indicates you are at the desired highest packet.

.



10.8.4 To Determine Current Position

In addition to the two range delimiters, the slider has a **blue current-position** indicator (see above). The current-position indicator shows where you are in the CATC Trace display with respect to the possible viewing range.

For example, suppose you set viewing range to packet 0 through packet 500 (the top range delimiter is at packet 0, and the bottom range delimiter is at packet 500). If you then move the current-position indicator on the slider to midway between the top and bottom delimiters, then packet 250 appears in the middle of the CATC Trace display.

10.8.5 To Reset Navigator Range

You can reset the Navigator range using the toolbar **Navigator Range** button. Press the button to bring up the Navigator Range drop-down menu (see Figure 10.24 on page 232).

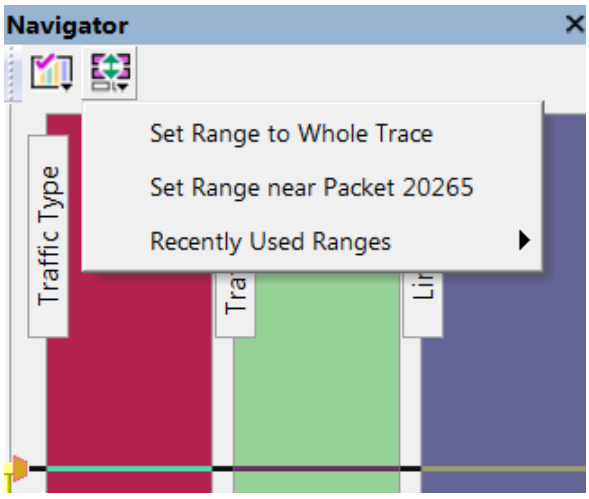


Figure 10.24: Navigator Range Dropdown Menu

The menu has the following options:

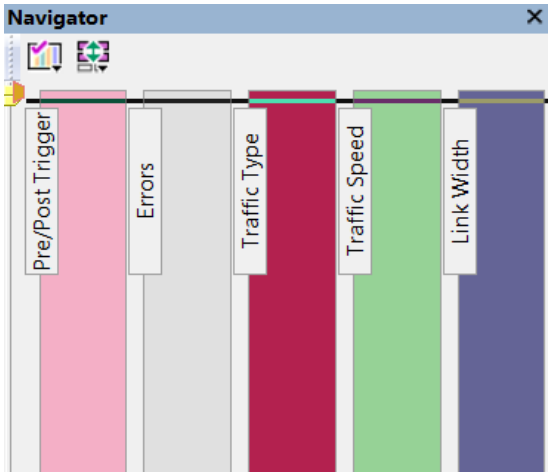
- **Set Range to Whole Trace**: Allows you to reset the range to include the entire

CATC Trace file contents. The top range delimiter is placed at the lowest packet number in the CATC Trace. The bottom range delimiter is placed at the highest packet number in the CATC Trace.

- **Set Range Near Packet xxx**: Allows you to collapse the range so that only the packets immediately above and below the xxx packet are displayed. The xxx packet is whatever packet is currently at the top in the CATC Trace display.
- **Recently Used Ranges**: Allows you to reset the range to any of a number of recently used (previously set) ranges.

10.8.6 Navigator Panes

You can display any combination of CATC Trace Navigator panes.



From left to right, the panes are: Pre/Post Trigger, Errors, Traffic Type, Traffic Speed, and Link Width. Each pane represents the entire CATC Trace with respect to different types of information. The top of each pane represents the start of the CATC Trace file, and the bottom represents the end of the CATC Trace file.

- **Pre/Post Trigger:** To view the trigger event in the CATC Trace and the relative size of pre-trigger and post-trigger portions of the CATC Trace. The two portions are set apart as different colors. The trigger event occurs at the point the two colors meet.
- **Errors:** To view any errors in the CATC Trace. A thin red line represents each error in the pane.
- **Traffic Type:** To view the types of packets that occur in the CATC Trace. A different color represents each packet type in the pane. The relative size of colored portions in the pane corresponds to the amounts of the various packet types in the CATC Trace. As described below, you can use the Navigator legend to change the types of packets that take precedence in the display.
- **Traffic Speed:** To view the speed that occurs in the CATC Trace.
- **Link Width:** To view the link width that occurs in the CATC Trace.

10.8.7 To Show/Hide Navigator Panes

You can show/hide any of the panes using pop-up menus accessible through left-click the **Navigator Panes** button or by right-click anywhere in any CATC Trace Navigator pane.

10.8.8 Navigator Slider

The Navigator slider appears at the left of Navigator panes. The slider has **yellow upper and lower range delimiters** and a **blue current-position** indicator.

The Navigator slider lets you to set the range of packets viewable in the CATC Trace display. In other words, it sets scrolling range of the display. You can scroll the display up to the lowest packet number in the viewing range. You can scroll the display down to the highest packet number in the viewing range.

10.8.9 CATC Trace Navigator Legend

The Navigator legend lets you control the display of content in Navigator panes.

You bring up the legend through the Navigator Pane's drop-down menu. Press the toolbar **Navigator Panes** button to access the menu. Select the **Legend** option to bring up the Navigator Legend dialog.

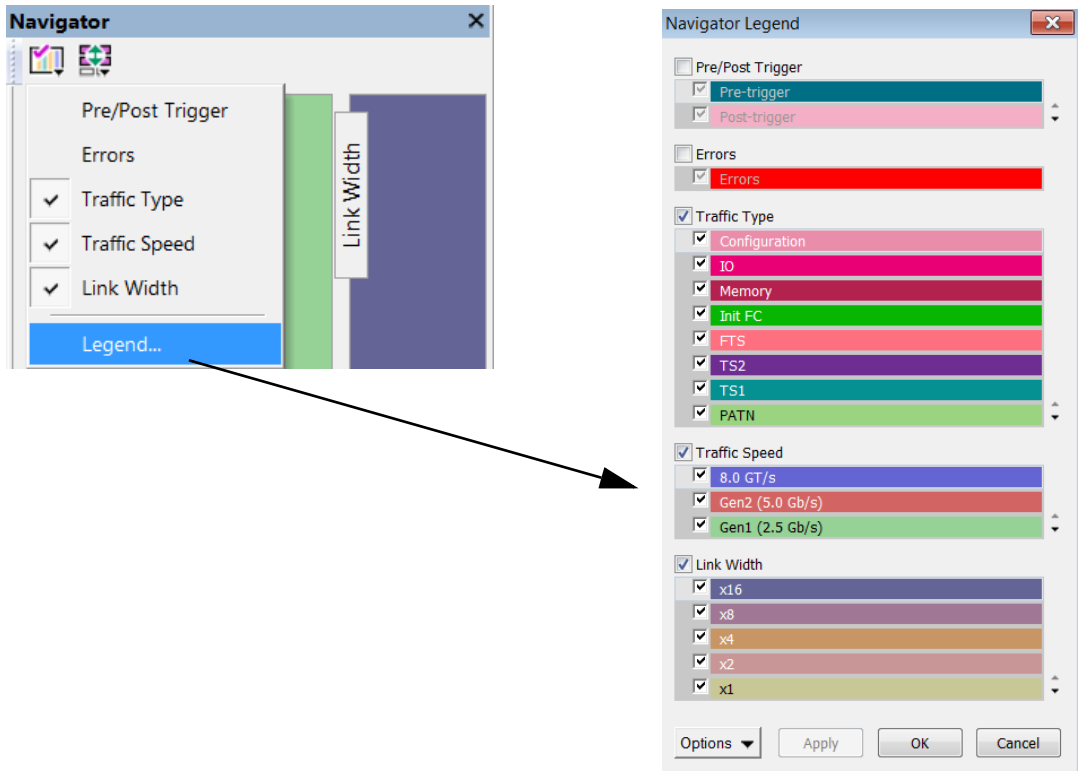


Figure 10.25: Navigator Pane and Navigator Legend Dialog

The Navigator Legend dialog has areas corresponding to each of the panes. Each area has check boxes that allow you to hide/display information in the pane. You can set the

priority of information displayed in the panes using the up and down triangles on the right.

10.8.10 Using the Legend to Show/Hide Navigator Panes

To use the legend to show/hide an entire pane, use the **checkbox** next to the name of each pane in the legend.

In the case of the Pre/Post Trigger and Errors areas, the action of show/hide in the legend is identical to that provided by CATC Trace Navigator pop-up menus.

In the case of the Traffic Types pane, there is no equivalent show/hide available through the pop-up menus.

10.8.11 Using the Legend to Set the Priority of Information Display

You can use the legend to set the priority of information displayed in the Pre/Post Trigger Traffic Type panes. This is a two-step process.

1. For a particular item in a pane, click the **column next to the checkbox** for the item. That labels the item as currently active.
2. Next, use the **up-down** at the lower-right of the area to move the item higher or lower in priority.

In the case of the Traffic Type pane, priority determines display priority of each packet type. For portions of the CATC Trace that are dominated by a particular packet type, this setting no effect: only the color corresponding to that packet type is displayed in that portion of the pane. Suppose, however, that part of the CATC Trace includes equal or near equal numbers of several types of packets. In that case, you can use the legend to select which among those types is represented in that portion of the Traffic Types pane. This allows you to view only packets of interest in crowded portions of the CATC Trace display.

10.9 Detail View

Click to show the Detail View of the selected packet.

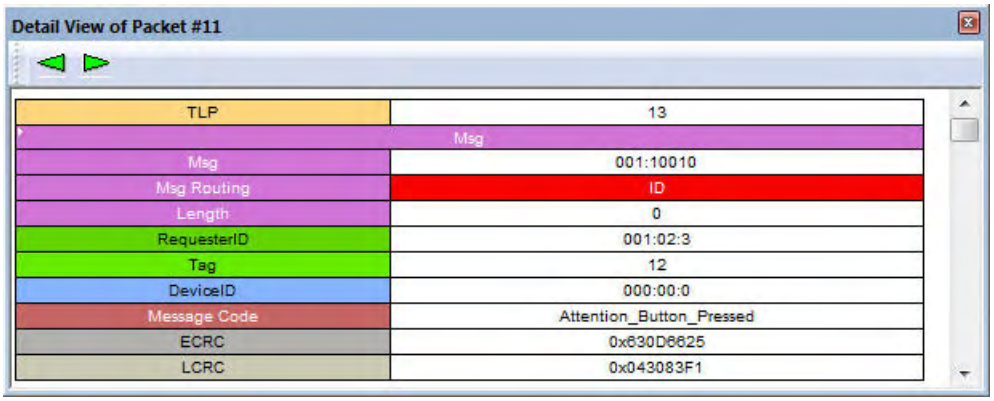


Figure 10.26: Detail View

10.10 LTSSM Flow Graph

The LTSSM Flow Graph shows link state transitions that the link goes through, as recorded in the CATC Trace file. To obtain the LTSSM Flow Graph, select **Report> LTSSM Flow Graph.**

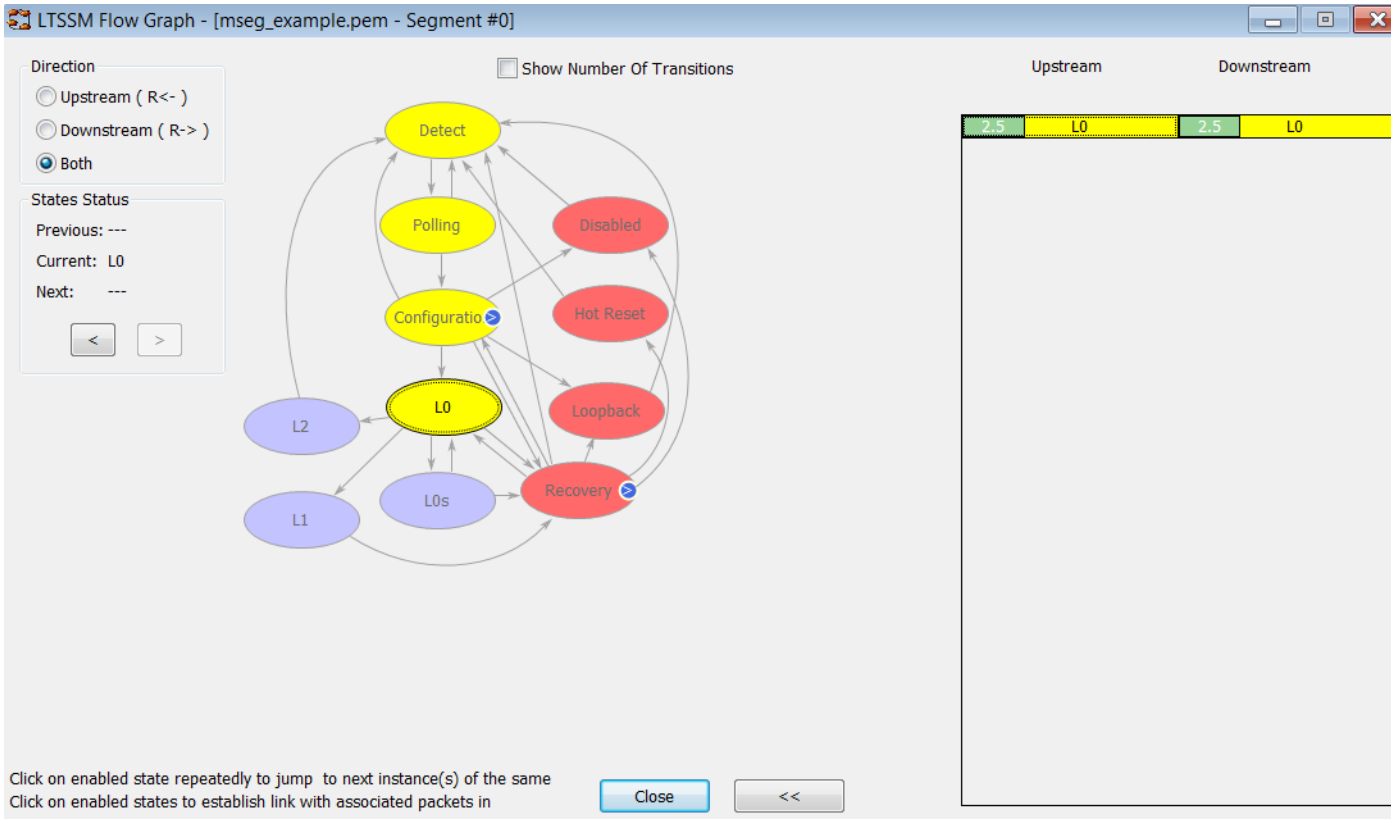


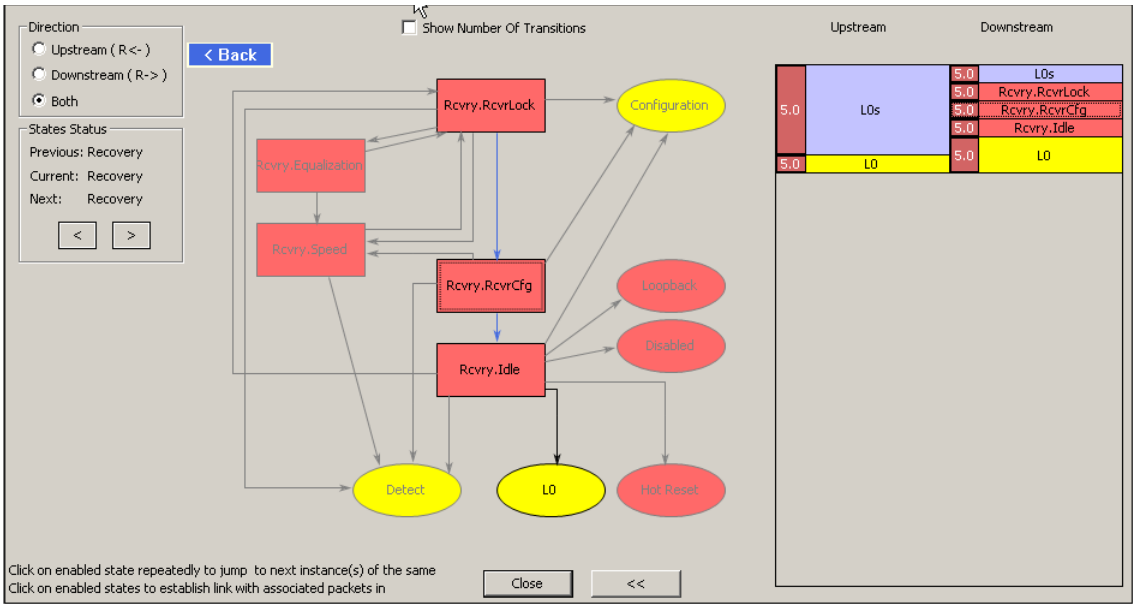
Figure 10.27: LTSSM Flow Graph Dialog

You can display the following directions:

- Upstream
- Downstream
- Both

You can **Show Number of Transitions**.

Click the blue button (on the Recovery state below) to see the sub-state (see figure on next page).



10.11 Packet Header Bar

The Packet Header bar shows packet header information.

To obtain the Packet Header bar, select **Report > Packet Header** or click the Packet Header toolbar icon.

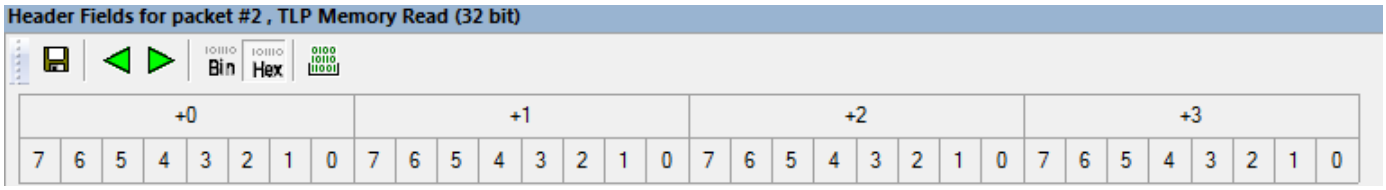


Figure 10.28: Packet Header Bar

The toolbar allows you to Save, go to Previous or Next, display Hexadecimal or Binary, and show the Packet Data window.

10.12 Packet Data Window

The Packet Data window shows packet or transaction payload.

To obtain the Packet Data window, select **Report > Packet Data**

or click the toolbar icon.

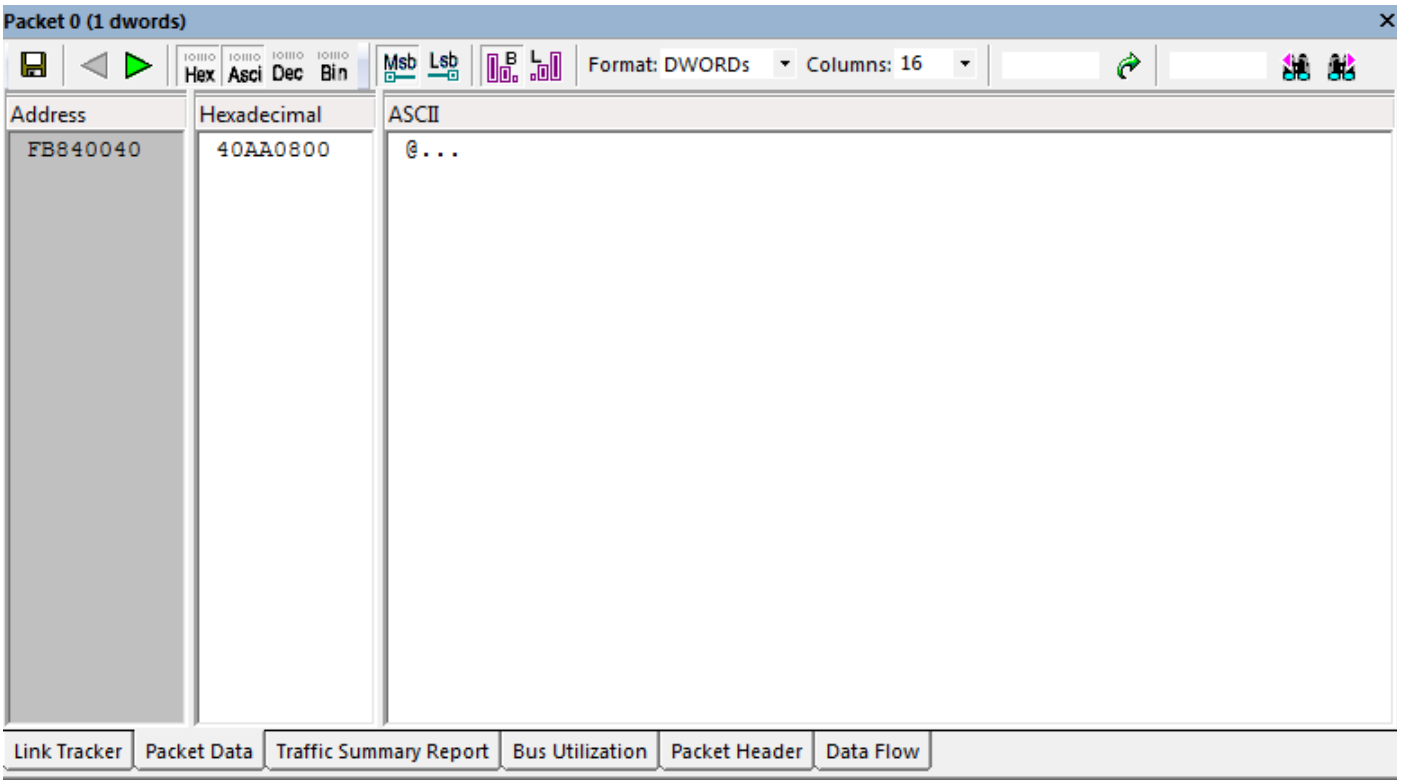
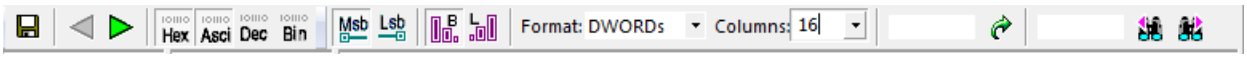


Figure 10.29: Packet Data Window

The toolbar allows you to Save; go to Previous or Next; display Hexadecimal, ASCII, Decimal, or Binary; use MSB Format or LSB Format; and use Big Endian or Little Endian.



Format and Columns allows you to enter the number of bytes, words, or dwords per line.

You can enter an Offset and scroll to it.

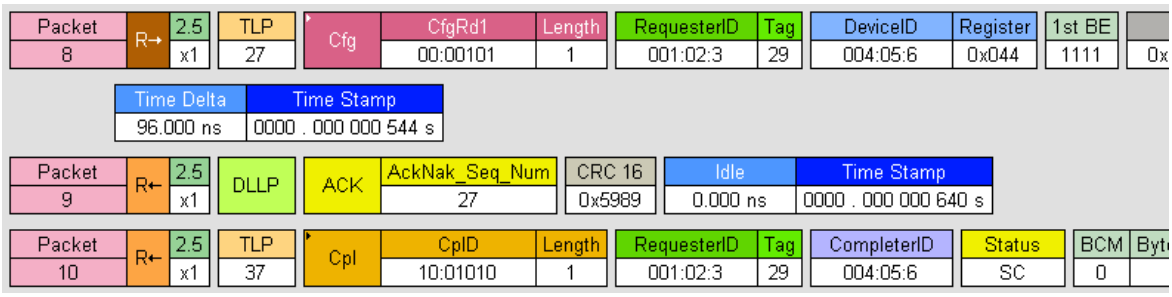
You can enter text and Search Previous or Search Next.

10.13 Configuration Space View

The Configuration Space View displays information about the Configuration Space state as of the current packet of the currently selected device. The view shows the Configuration Space Header and the PCI-compatible or PCI Express Capability Structures.

To display the Configuration Space View for a device at a packet:

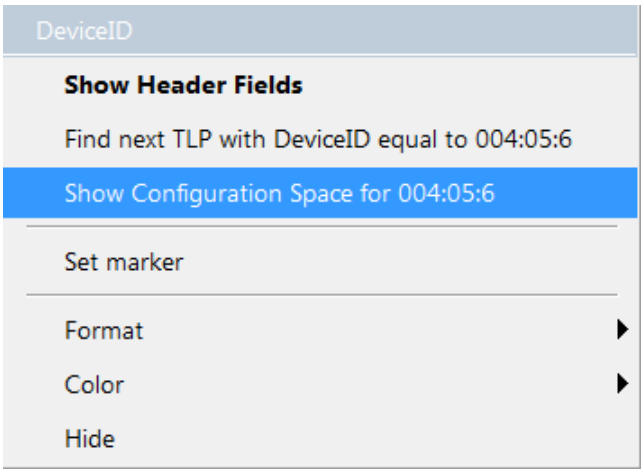
1. Open a CATC Trace, such as the sample file **cfg_pci_express.pex**.
2. Scroll to a packet with a Configuration header.



3. Select **Report > Configuration Space > <device>** to display the Configuration Space View.

   or

   Click a **CompleterID** or **DeviceID** field. A pop-up menu opens.



Select **Show Configuration Space for xxxx** from the menu, where **xxxx** is the device number. The Configuration Space View displays (see Figure 10.30 on page 240).

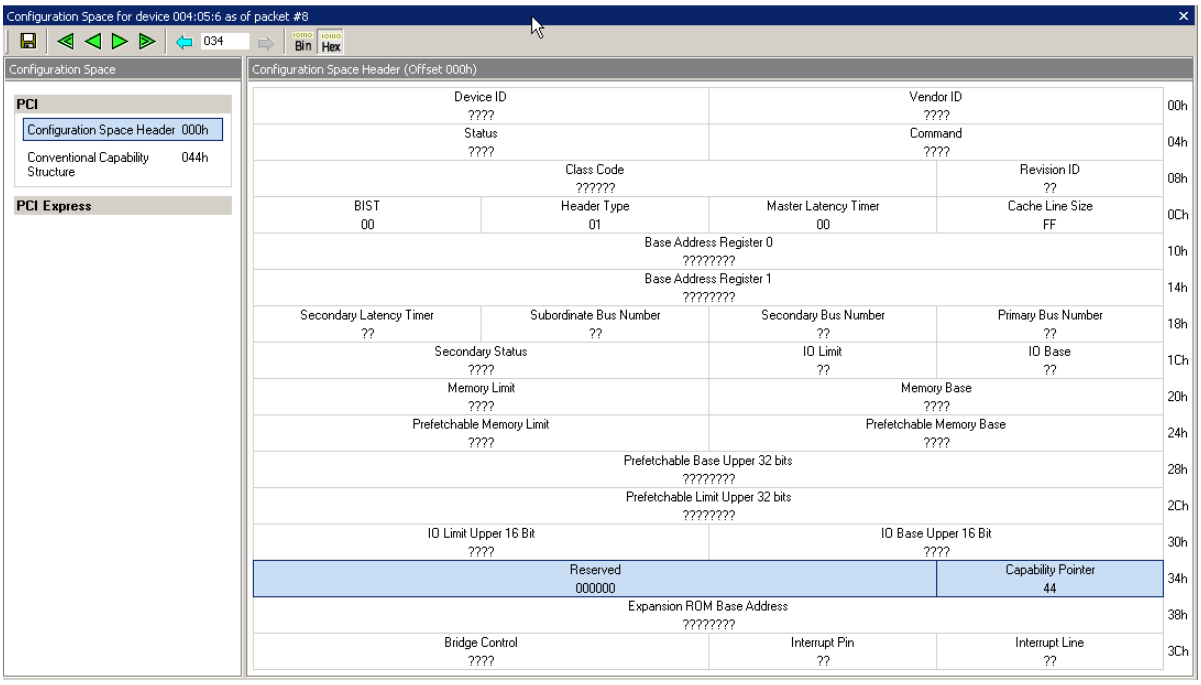

Configuration Space for device 004:05:6 as of packet #8
034
Bin
Hex
Configuration Space
PCI
Configuration Space Header 000h
Conventional Capability Structure 044h
PCI Express
Configuration Space Header (Offset 000h)
Device ID ???? Vendor ID ????
Status ???? Command ????
Class Code ?????? Revision ID ??
BIST 00 Header Type 01 Master Latency Timer 00 Cache Line Size FF
Base Address Register 0 ????????
Base Address Register 1 ????????
Secondary Latency Timer ?? Subordinate Bus Number ?? Secondary Bus Number ?? Primary Bus Number ??
Secondary Status ???? IO Limit ?? IO Base ??
Memory Limit ???? Memory Base ????
Prefetchable Memory Limit ???? Prefetchable Memory Base ????
Prefetchable Base Upper 32 bits ????????
Prefetchable Limit Upper 32 bits ????????
IO Limit Upper 16 Bit ???? IO Base Upper 16 Bit ????
Reserved 000000 Capability Pointer 44
Expansion ROM Base Address ????????
Bridge Control ???? Interrupt Pin ?? Interrupt Line ??
00h
04h
08h
0Ch
10h
14h
18h
1Ch
20h
24h
28h
2Ch
30h
34h
38h
3Ch

Figure 10.30: Configuration Space View

On the left, the view displays the Configuration Space for the selected CompleterID or DeviceID at the current packet. You can select **Configuration Space Header** or a **Capability Structure.**

The right displays the decoded data of the selected Configuration Space Header or a Capability Structure, up to the current packet. (The decoding builds while navigating through the next packets.)

The Configuration Space View toolbar allows you to save, go to First, go to Previous, go to Next, go to Last, go to Previous Access to Selected Configuration Space Register, go to Next Access to Selected Configuration Space Register, and display Hexadecimal or Binary.

Note: See Appendix A “Configuration Space Decoding” on page 287.

10.14 Using Unit Metrics

For every protocol unit at the Link or Split transaction level, PCIe Protocol Suite™ calculates and displays a set of metrics. Metrics are measurements of key operating parameters. You can use metrics to evaluate performance of traffic in the CATC Trace stream.

You can view metrics information in the CATC Trace display, the Traffic Summary window, and the Bus Utilization window.

PCIe Protocol Suite defines different metrics for Link and Split transactions.

10.15 Metrics Defined for Link Transactions

- **Number of Packets**: The total number of packets that compose this Link transaction.
- **Payload**: The number of data payload bytes this Link transaction transferred.
- **Response Time**: The time it took to transmit this Link transaction on the PE link, from the beginning of the first packet in the transaction to the end of the last packet in the transaction.
- **Data Throughput**: The payload divided by response time, expressed in megabytes per second.

Note: Usually, the Number of Packets metric for a link transaction is two (in case of explicit acknowledge) or one (in case of implicit acknowledge). However if Naks/link level retries are involved, this metric might be higher. As a result, the Number of Packets metric is useful in highlighting unusual link transactions.

10.15.1 Metrics Defined for Split Transactions

The following types of metrics currently are defined for Split transactions:

Number of Link Transactions: The total number of Link transactions that compose this Split transaction.

Payload: The number of payload bytes this Split transaction transferred.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction;

Data Throughput: The transaction payload divided by response time, expressed in megabytes per second.

Latency Time: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

Note: The Number Of Link Transactions metric for a Split Transaction usually is two for a Configuration or IO request. It can be bigger then two for a Memory Read request.

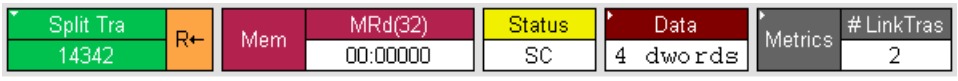
10.16 Show Metrics in the CATC Trace Display

In the CATC Trace view display of Link Transaction or Split Transaction levels, all metrics information applicable to a specific protocol unit is displayed in a Metrics header. The header is located close to the end of the unit, in front of the Time cell. You can expand and collapse the header to show or hide the metrics information.

10.16.1 Collapsed Metrics Header Display

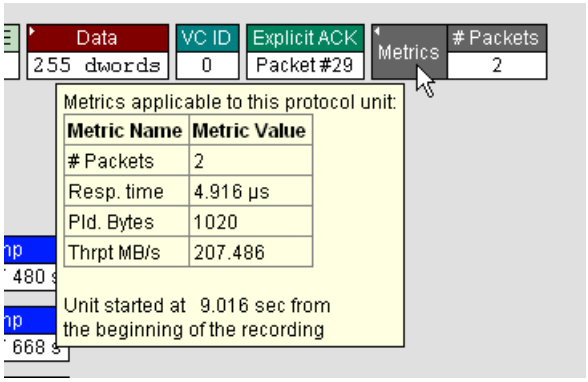
Following is a collapsed metrics display for a unit of Link Transaction. The collapsed header display shows only the metrics cell representing the Number of Packets (see the following figure).

Following is a collapsed metrics display for a unit of Split Transaction. The collapsed header display shows only the metrics cell representing Number of Link Transactions.



10.16.2 Metrics Tool Tip Display

In both CATC Trace level views, you can view the summary of all the unit metrics in the Metrics header tool tip. To view the tool tip, simply place the mouse cursor over the Metrics header. Following is the tool tip for a unit in the Link Transaction view.

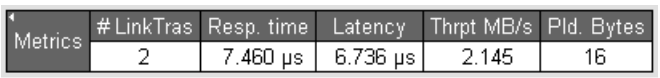


Note: The tool tip also presents information for time passed from the start of the recording till the beginning of this Link or Split Transaction.

10.16.3 Expanded Metrics Header Display

When you expand the Metrics header, the display creates a separate cell for each applicable metric:

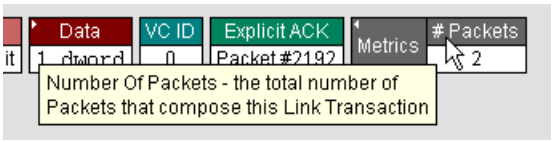
The following is the expanded Metric header for a unit in the Split Transaction view.



The following is the expanded Metric header for a unit in the Link Transaction view.

Metrics	# Packets	Resp. time	Pld. Bytes	Thrpt MB/s
	2	536.000 ns	64	119.403

Note: Each of the metric cells pops up a tool tip window with the explanation of what the metric means.

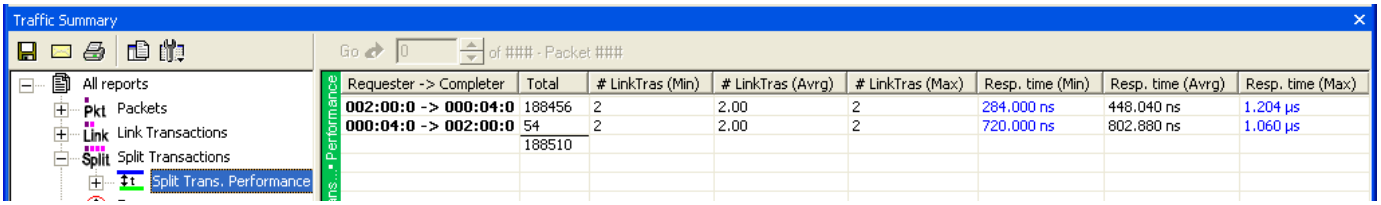


10.17 Show Metrics in the Traffic Summary Window

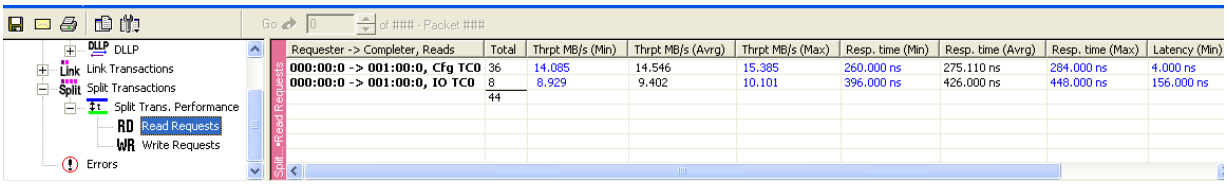
Some of the Traffic Summary reports at the Link and Split Transaction levels are based on metrics collected for the corresponding protocol units in the CATC Trace.

10.17.1 Reports at Split Transaction Level

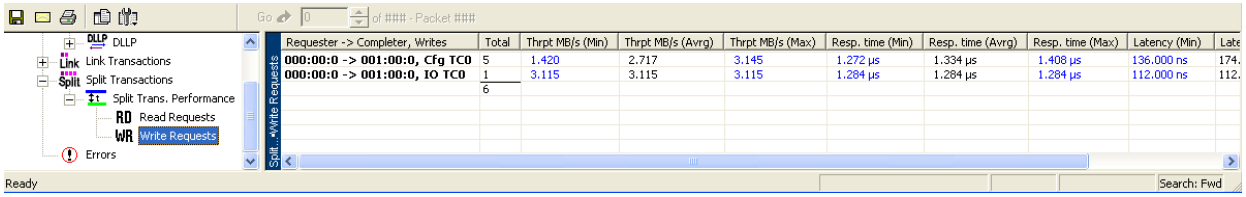
Split Transaction Performance: This report table groups the Split Transactions by Requester-Completer pair and displays Minimum/Average/Maximum data for Number Of Link Transactions and Response Time metrics.


Traffic Summary
All reports
Packets
Link Transactions
Split Transactions
Split Trans. Performance
Performance
Requester -> Completer | Total | # LinkTras (Min) | # LinkTras (Avrg) | # LinkTras (Max) | Resp. time (Min) | Resp. time (Avrg) | Resp. time (Max)
000:00:0 -> 000:04:0 | 188456 | 2 | 2.00 | 2 | 284.000 ns | 448.040 ns | 1.204 µs
000:04:0 -> 002:00:0 | 54 | 2 | 2.00 | 2 | 720.000 ns | 802.880 ns | 1.060 µs
188510

Read Requests Performance: This report table includes only the Split Transactions that present Read Requests (Configuration, IO and Memory). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics.


DLLP
Link Transactions
Split Transactions
Split Trans. Performance
Read Requests
Write Requests
Errors
Requester -> Completer, Reads | Total | Thrpt MB/s (Min) | Thrpt MB/s (Avrg) | Thrpt MB/s (Max) | Resp. time (Min) | Resp. time (Avrg) | Resp. time (Max) | Latency (Min)
000:00:0 -> 001:00:0, Cfg TC0 | 36 | 14.085 | 14.546 | 15.385 | 260.000 ns | 275.110 ns | 284.000 ns | 4.000 ns
000:00:0 -> 001:00:0, IO TC0 | 8 | 8.929 | 9.402 | 10.101 | 396.000 ns | 426.000 ns | 448.000 ns | 156.000 ns
44

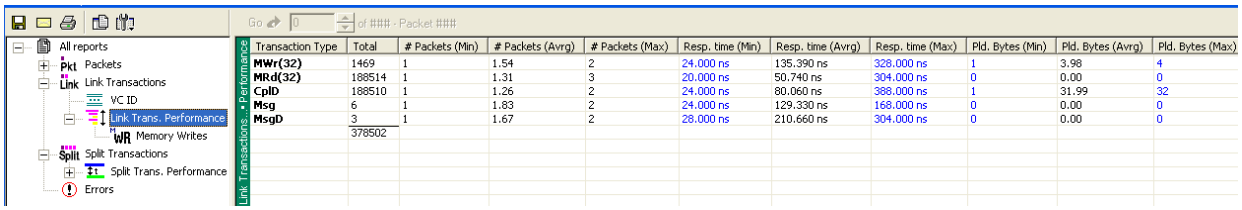
Write Requests Performance: This report table includes only the Split Transactions that present Write Requests (Configuration and IO). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics (see the following figure).



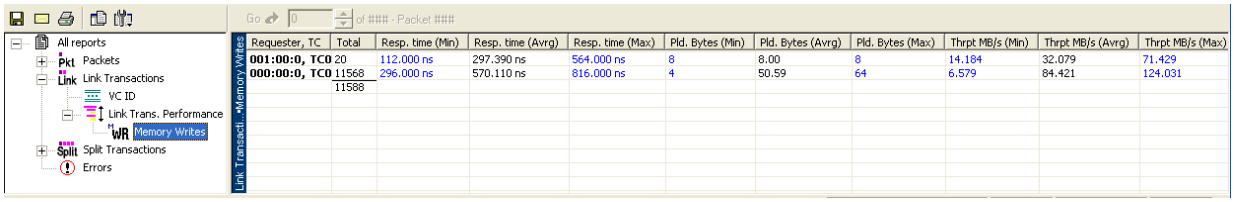
10.17.2 Reports at the Link Transaction Level

The following metric-based reports are displayed at the Link Transaction level:

Link Transaction Performance: This report table groups the Link Transactions by TLP Type and displays Minimum/Average/Maximum data for Number Of Packets, Response Time and Payload Bytes metrics.



Memory Writes: This report table includes only the Link Transactions that present Memory Write Requests. Memory Writes are the only (posted) requests that don't get promoted to the Split transaction level, therefore their performance should be viewed at the Link transaction level. The table groups Memory Writes by the combination of Requester ID and Traffic Class and displays Minimum/Average/Maximum data for Response Time, Payload and Throughput metrics.



The following features apply to all of the report tables described above for the Split Transaction and Link Transaction levels:

- Each report row for the defined tables contains the total number of units in this group for the CATC Trace (total number of units for Split Transaction performance, Read Requests performance, Memory Writes, and so on).
- In many cases, the Maximum and Minimum values in the report tables are navigable. By clicking table cells, you reposition the corresponding CATC Trace view to the Split or Link Transaction that has yielded this maximum or minimum value. This can help you to find specific units in the CATC Trace, such as transactions that produced spikes in Response Time or Throughput.

10.18 Show Metrics in the Bus Utilization Window

The Bus Utilization window provides graphs for packet-level information in the CATC Trace. The window also provides graphs for information on Split and Link Transaction levels, plotted over time. The graphs for Split and Link Transaction levels are based on metrics collected for the transactions throughout the CATC Trace.

The seven graphs related to Split and Transaction levels are:

1. Pending Requests at Split Transaction level.
2. Response Time at Split Transaction level.
3. Latency Time at Split Transaction level.
4. Throughput Per Transaction at Split Transaction level.
5. Response Time and Latency Time at Split Transaction level (combined graph).
6. Response Time at Link Transaction level, for Memory Writes only.
7. Throughput at Link Transaction level, for Memory Writes only.

The following is an example of Bus Utilization window display of graph numbers 1, 4, 5, 6 and 7:

10.18.1 Unit-Based Averaging

The Analyzer builds metric graphs using unit-based averaging (as opposed to time-based averaging). For the total duration of a certain request (or Memory Write transaction), the graph value is assumed equal to the corresponding metric for this request (transaction). If there are overlapping operations for a certain time period, then the value is calculated as an average of metric values for all the overlapped requests (transactions).

It is important to remember that the Analyzer uses unit-based averaging rather than time-based averaging. Time-based averaging can be misleading in some situations. For example, consider the Throughput Per Transaction graph. Sometimes, while many outstanding requests are in progress, latency (and response time) grows for each of the transactions, resulting in a lower throughput per transaction over time (which is reflected in the graph). This happens even though aggregated throughput across all the transactions is constant.

10.18.2 Bus Utilization Window Features

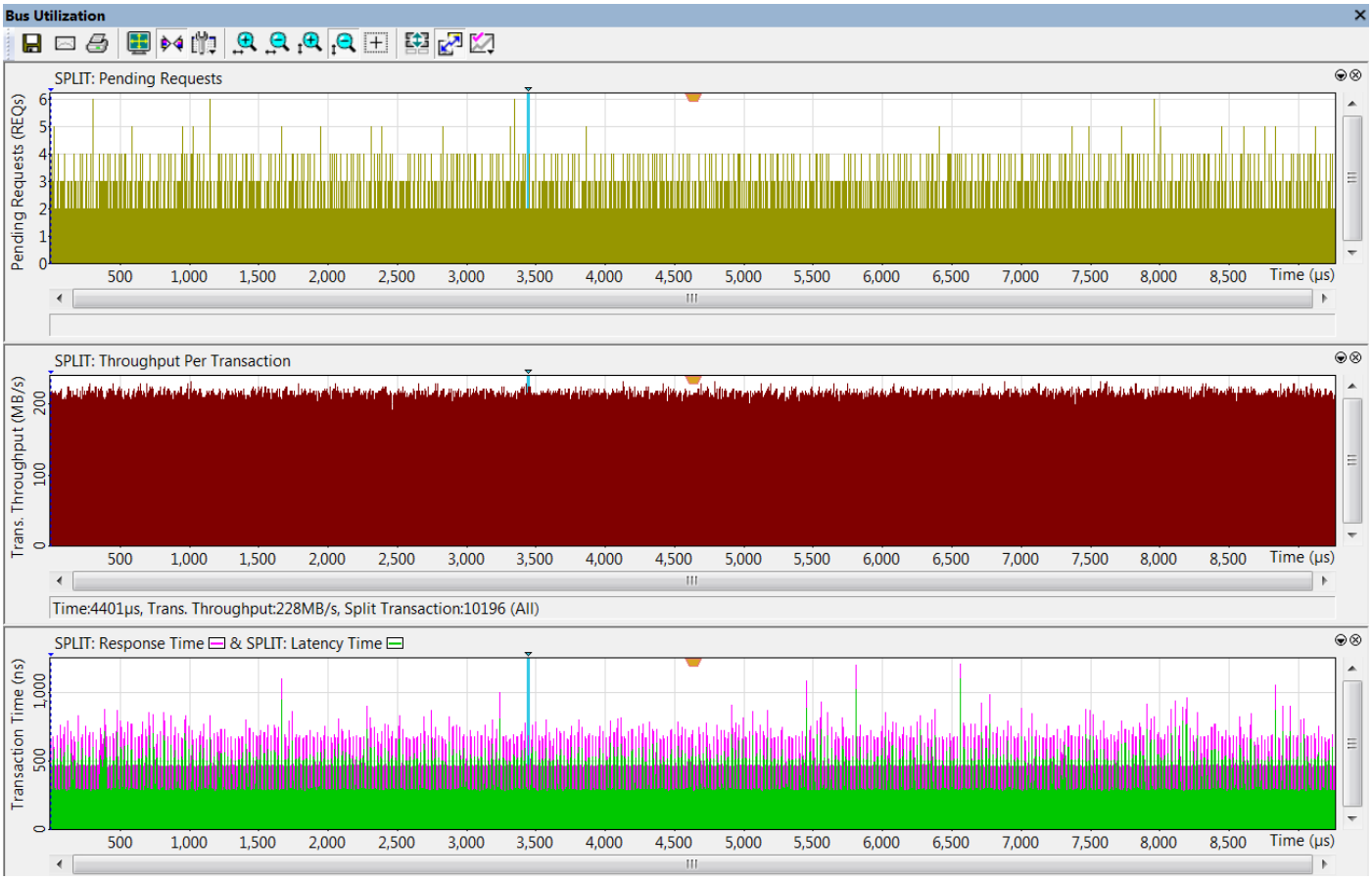
For the seven Split- and Transaction-level graphs listed, all Bus Utilization window features are available, such as zooming in/out, changing scale type, scrolling, context-sensitive status, and graph synchronization. See Bus Utilization and Bus Utilization Buttons for more on these features.

Note: Clicking a certain place within a graph area repositions the CATC Trace display at the Link or Split transaction level to the transaction that was in progress at that time.

10.18.3 Split Transaction Level Graphs

Transactions at the Split level combine all the non-posted requests with corresponding completions. This includes Configuration and IO Read and Write requests, as well as Memory Read requests.

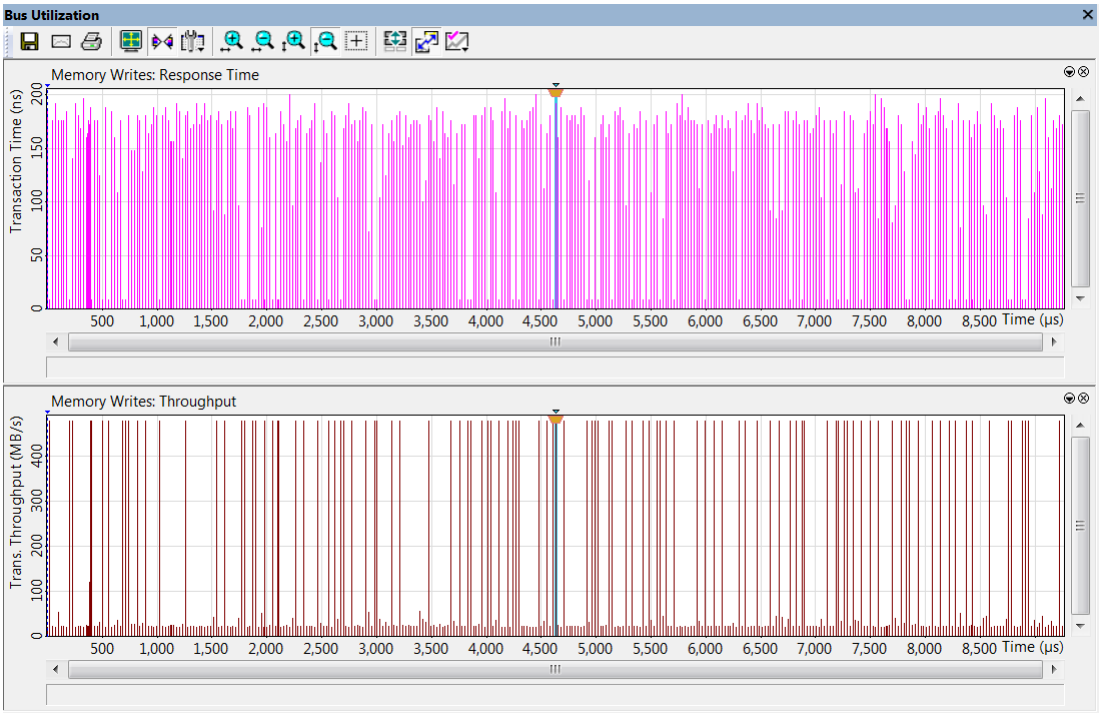
The following figure shows the graphs for the Split level:



Note: The Pending Requests graph is not directly defined by metrics, but it is useful when considering metrics. The Pending Requests graph presents the unit-averaged number of requests that were pending (in progress) at any moment of time. It allows you to correlate the number of requests posted to a completer with other performance metrics.

10.18.4 Link Transaction Level Graphs

Memory Writes are the only (posted) requests that do not get promoted to the Split transaction level. Therefore, Memory Write performance should be viewed at the Link Transaction level. That is the reason graphs at the Link level only present the Memory Write-related metrics and are titled **Writes: Response Time:** and **Writes: Throughput** (see the following figure).



10.19 Real-Time Statistics Window

The Real-Time Statistics Window displays Link Utilization, performance measurements, and statistical values for a PCI Express link plotted in real time.

Click to open the Real-Time Statistics window (see Figure 10.31 on page 249).

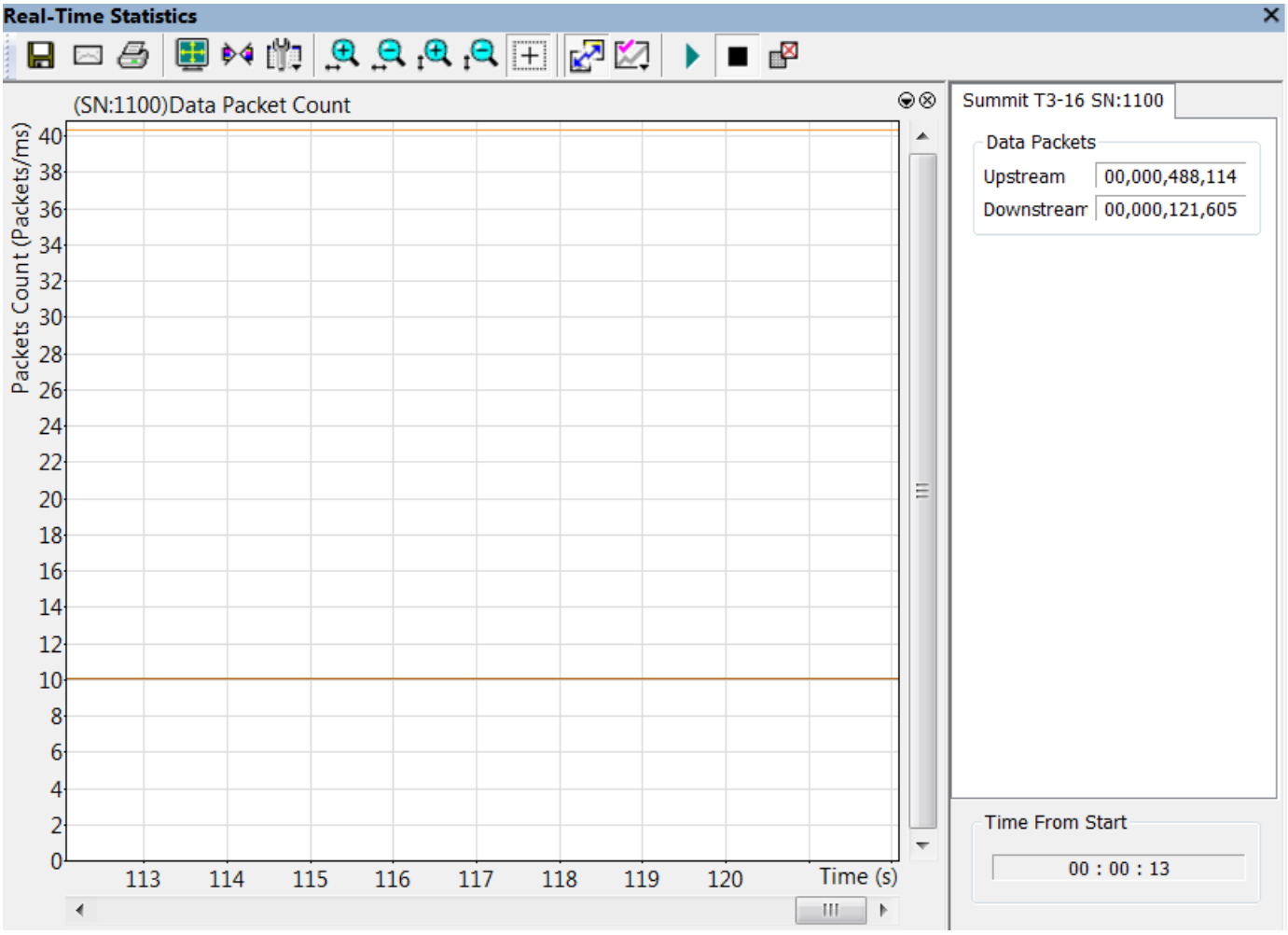


Figure 10.31: Real-Time Statistics Dialog

Start **PCI Express™** link activity.

To start the monitor, press .

To stop the monitor, press .

The remaining Real-Time Statistics buttons provide options for changing the format of the display.

Additional formatting options are available through the Real-Time Statistics pop-up menu and the Real-Time Statistics toolbar.

10.19.1 Real-Time Statistics Buttons

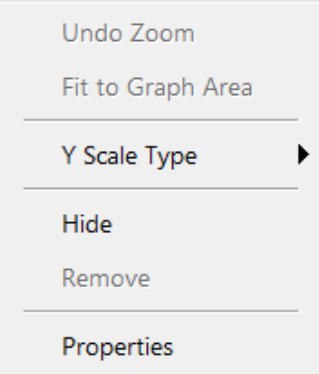
Additional formatting options are available through the Real-Time Statistics toolbar.

Button	Function
	Save. Saves Real-Time Statistics data to bitmap file (*.bmp).
	Email. Opens an email and attaches a bitmap file of the Real-Time Statistics data.
	Print. Prints the Real-Time Statistics data.
	Full Screen. Maximizes the Real-Time Statistics window.
	Synchronize Views.Synchronize the current view with other open views.
	View Settings. Opens a sub-menu with the following choices: • Orient Horizontally • Tile Vertically • Show Markers • Show Plumbline • Status >> • Bar • Tool tips • None • Grid Lines >> • Both Axes • X Axis • Y Axis • No Grid • Grid on Top • Fonts & Colors
	Horizontal zoom in
	Horizontal zoom out
	Vertical zoom in

	Vertical zoom out
	Click and Drag Zoom. Click and drag to zoom in on a part of the graph.
	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Allows you to hide or display the graphs and the counters. You can toggle Statistics Accumulation, Link Utilization, Data Payload Throughput, and Data Packet Count.
	Start real-time statistics. Starts the real-time statistical monitor.
	Stop real-time statistics. Stops the real-time statistical monitor.
	Reset Graphs. Resets the graphs.

10.19.2 Real-Time Statistical Monitor Pop-up Menu

Additional formatting options are available through the Real-Time Statistics pop-up menu. Right-click a graph in the Real-Time Statistical Monitor window to display a pop-up menu with options for changing the format of the display.



Undo Zoom: If you have zoomed in, this command undoes the zoom.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format.
- **Logarithmic**: Converts display to logarithmic format.

Hide: Hides the selected graph

Properties: Opens a dialog box with options for changing the Title, Appearance, and Color of the graph.

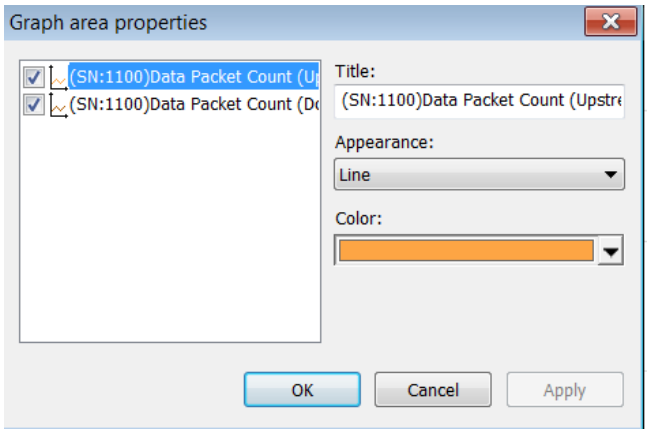


Figure 10.32: Graph Area Properties Display

10.19.3 Real-Time Statistics Graph Areas

The Real-time Statistics window has three graph areas:

- Link Utilization
- Data Payload Throughput
- Data Packet Count

Each graph area has Upstream and Downstream graphs for a device (if connected to a host machine), plus as many graphs as Exerciser devices connected to the host machine.

The Statistics Accumulation area shows the PCIe Protocol Suite statistics tab, plus as many tabs as Exerciser devices connected (see Figure 10.33 on page 253):

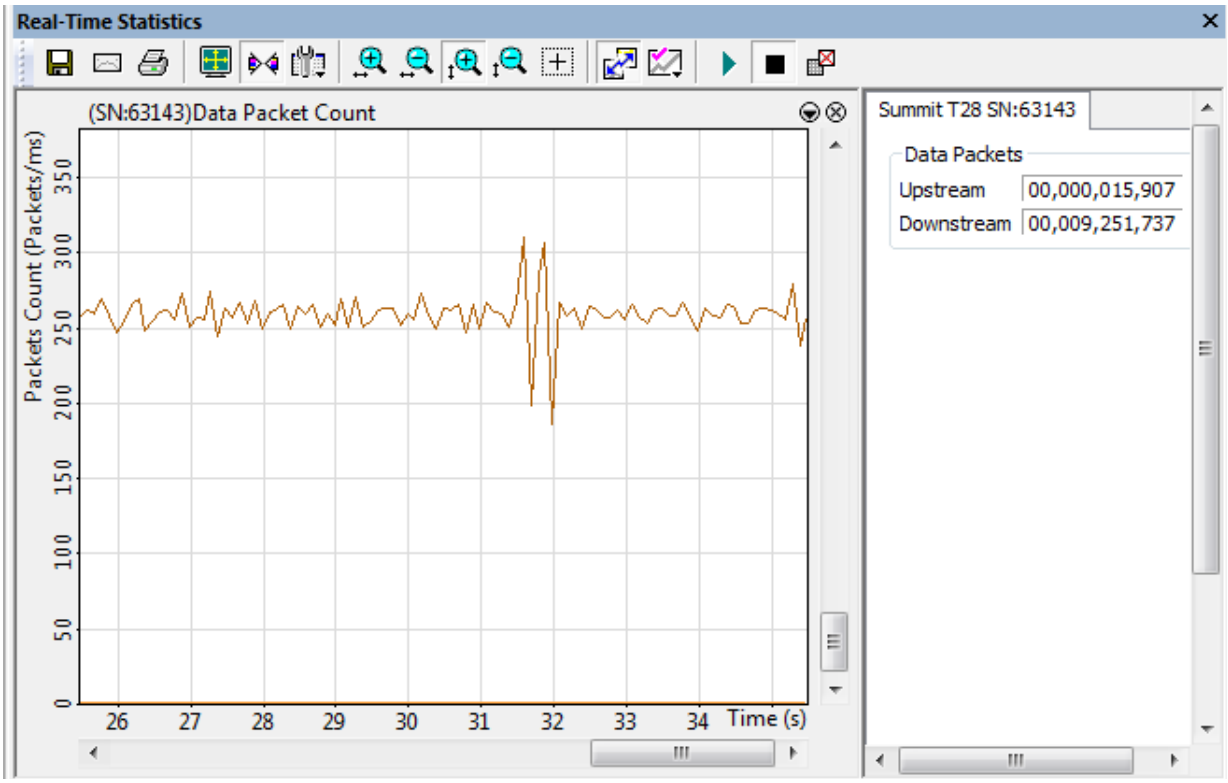


Figure 10.33: Real-Time Statistics Graph Display

For each Exerciser device, the following information is displayed:

- Number of data packets
- Payload size
- **InitFC complete status**: Yes/No
- **Link State**: Possible states are:
  - DETECT_QUIET
  - DETECT_ACTIVE
  - POLLING_ACTIVE
  - POLLING_CONFIG
  - CONFIG_LINKWIDTH_START
  - CONFIG_LINKWIDTH_ACCEPT
  - CONFIG_LANENUM_WAIT
  - CONFIG_LANENUM_ACCEPT
  - CONFIG_COMPLETE
  - CONFIG_IDLE
  - L0
  - L0S_IDLE
  - L0S_FTS
  - L1
  - RECOVERY_RCVRLOCK
  - RECOVERY_RCVRCFG
  - RECOVERY_IDLE
  - HOT_RESET

- DISABLED

10.20 Memory I/O Space Editor

The Memory I/O Space Editor allows you to create a new Memory I/O Space file or open an existing Memory I/O Space file. It is used in conjunction with Teledyne LeCroy Trainer products. Select **Tools > Memory I/O Space Editor** to display the Memory Space Editor dialog.

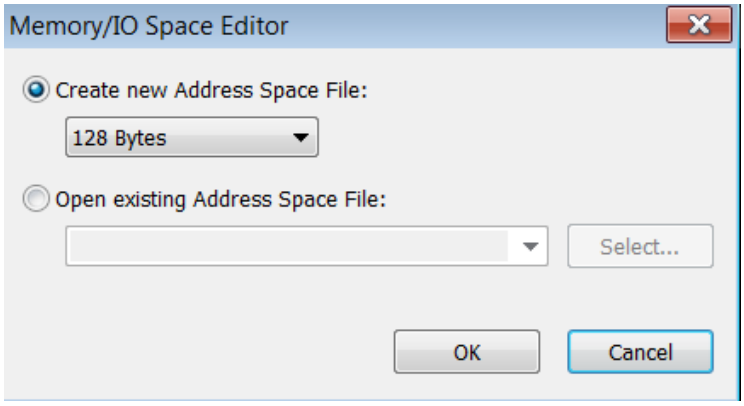


Figure 10.34: Memory I/O Space Editor Dialog

10.21 TC to VC Mapping

Select **Tools > TC to VC Mapping** displays how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions).

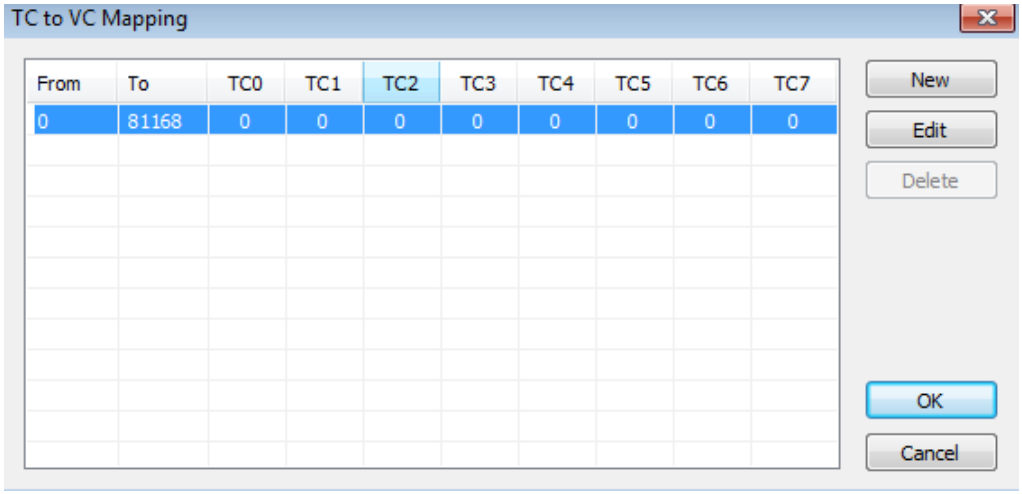


Figure 10.35: TC to VC Mapping Dialog

10.22 Timing and Bus Usage Calculations

10.22.1 Timing Calculator

The Timing and Bus Usage Calculator allows you to calculate time between packets.

Select **Tools > Timing Calculations** to obtain the Timing Calculator dialog. You can display the timing information in MB or Mb (see Figure 10.36 and Figure 10.37 on page 257).

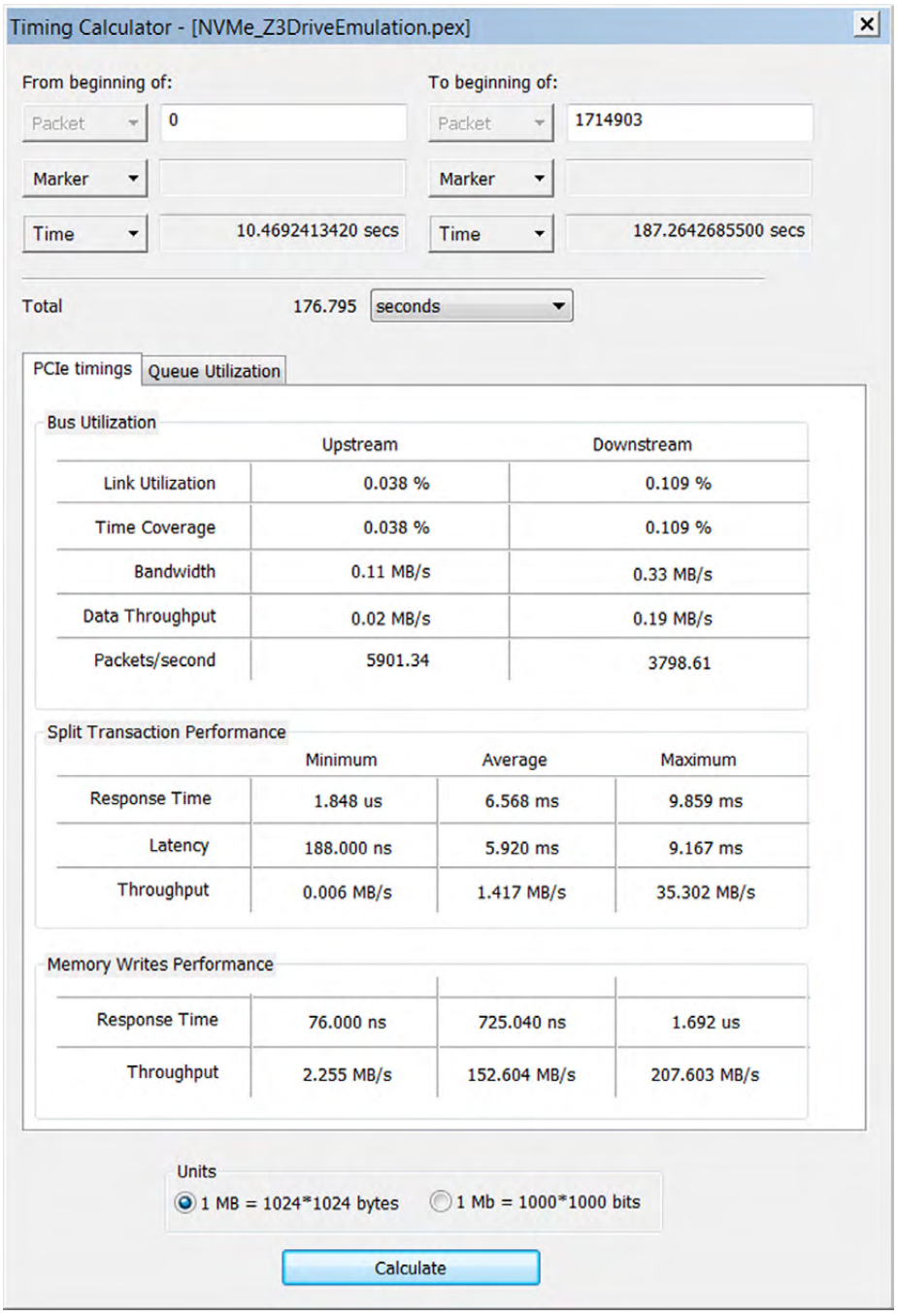


Figure 10.36: Timing Calculator Dialog (MB Format)

Total Time: Total time from beginning of the first unit to beginning of the second unit.

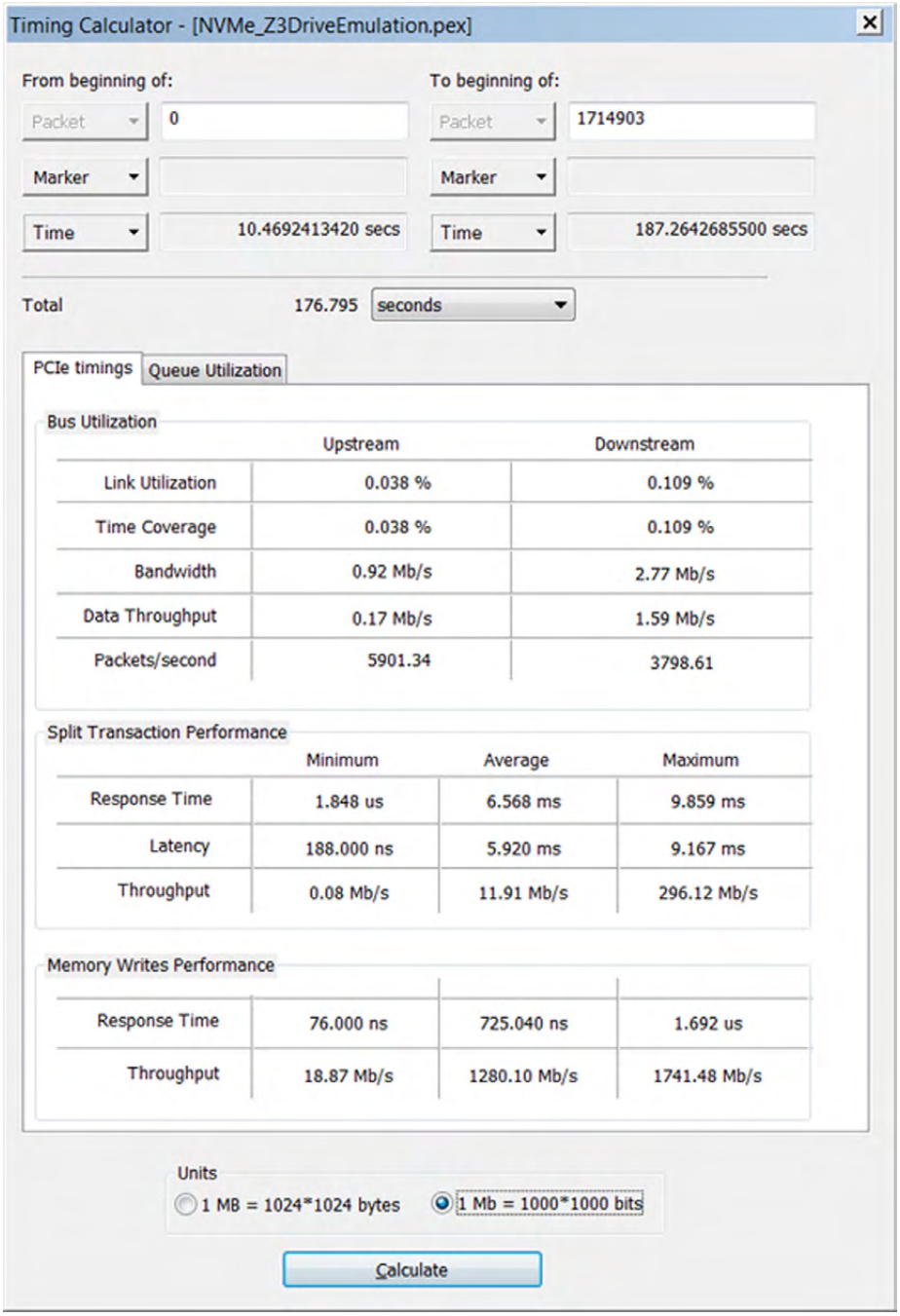


Figure 10.37: Timing Calculator Dialog (Mb Format)

10.22.2 Queue Utilization

The Queue Utilization tool allows you to visualize the traffic on the submission queues (SQ) and command queues (CQ) within a time interval. The default interval is the entire trace. The graph is generated using the Calculate button at the bottom of the dialog (see Figure 10.38) below.

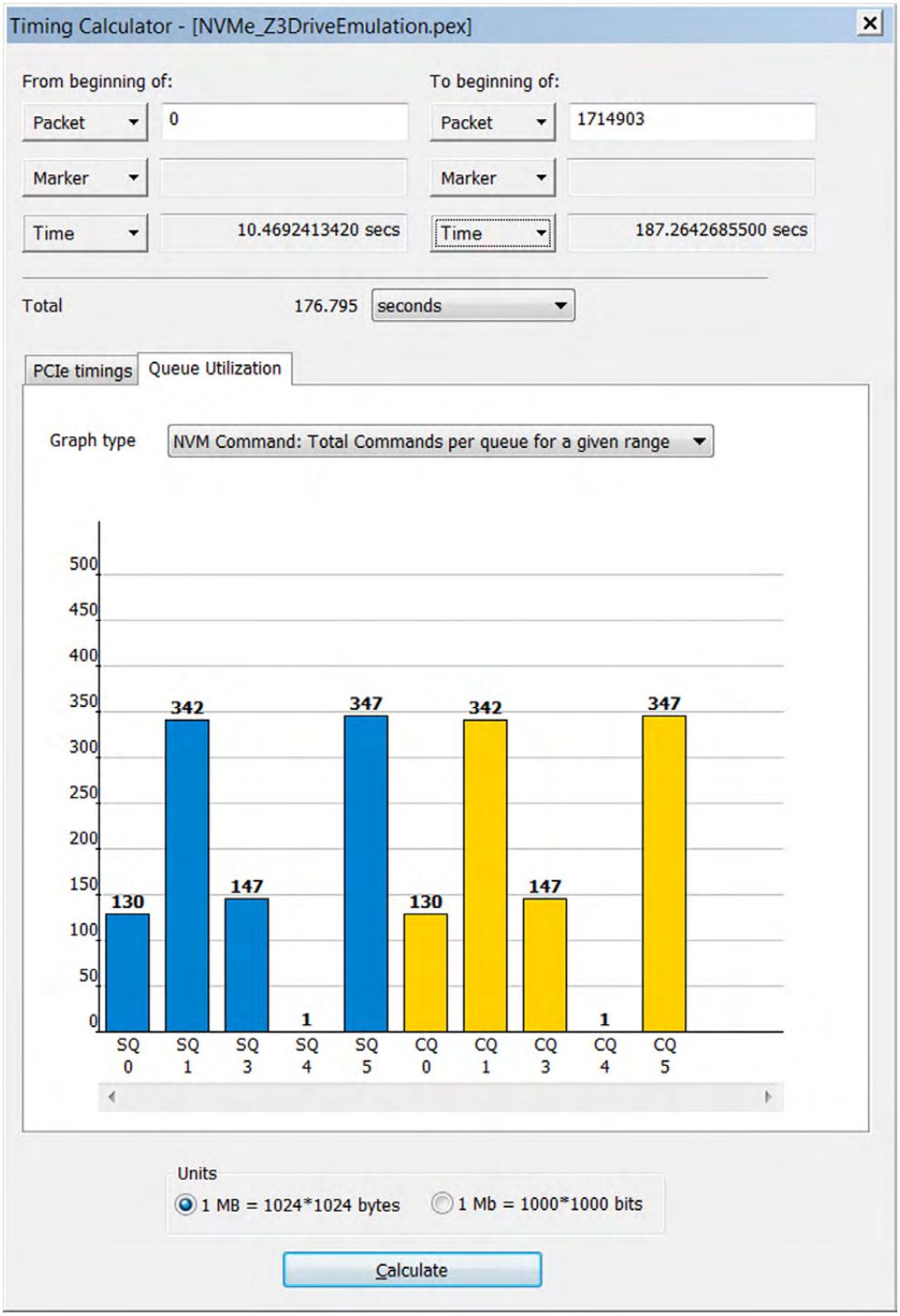


Figure 10.38: NVMe Queue Utilization Dialog

10.22.3 Bus Utilization

This portion of the Timing Calculator window gives values that are cumulative for all packets during the timing period. For example, throughput is combined throughput of all packets during the timing period.

Upstream is from endpoint devices to the root complex. Downstream is from the root complex to endpoint devices.

Link Utilization: Percentage of non-idle symbols in total number of symbols transferred.

Time Coverage: Percentage of non-idle symbol times in total number of symbol times. (Non-idle symbol time occurs when at least on one of the lanes there were non-idle symbols transferred.)

Bandwidth: Number of non-idle symbol bits transferred per second.

Data Throughput: Number of TLP payload bytes transferred per second.

Packets/second: Number of packets transferred per second.

10.22.4 Split Transaction Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Split transactions during the timing period. For example, minimum throughput is throughput of the Split transaction that passes the least amount of data. Maximum throughput is throughput of the Split transaction that passes the most amount of data. Average throughput is the average calculated for all Split transactions during the timing period.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction.

Latency: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

Throughput: The transaction payload divided by response time, expressed in megabytes per second.

10.22.5 Memory Writes Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Memory Write transactions during the timing period. For example, minimum throughput is throughput of the Memory Write transaction that passes the least amount of data. Maximum throughput is throughput of the Memory Write transaction that passes the most amount of data. Average throughput is the average calculated for all Memory Write transactions during the timing period.

Response Time: The time it took to transmit this Memory Write on the PE link, from the beginning of the first packet in the Memory Write to the end of the last packet in the Memory Write.

Throughput: The Memory Write payload divided by response time, expressed in megabytes per second.

10.23 PCIe SSD Base Address Mapping

In order for NVMe, PQI, AHCI, ATA, SOP and SCSI decoding to work correctly, the PCIe Protocol Suite software needs to know the Memory Base Address of the device. In cases when Base Address assignment is recorded in the trace, the software will determine all the values automatically. If the Base Address assignment is not present in the trace, you can specify the values manually using this dialog. You need to select the type of the device (NVMe, PQI, AHCI, ATA, SOP or SCSI) and set the value of the Base Address by selecting **Tools > PCIe SSD Base Address Mapping**. The PCIe SSD Configuration dialog displays (see Figure 10.39 on page 264).

Note: From software release 6.63 onwards, users are able to decode NVMe/PQI traces which are lacking configuration space and administration information, from release 6.70 this is applicable to AHCI traces, from release 7.00 this is applicable to ATA traces and from release 7.10 this is applicable to SOP and SCSI traces.

Note: From software release 7.30 onwards, multiple NVMe devices can be decoded from the same trace.

Note: From software release 7.34 onwards, the SSD Dialog displays the Device Name as read in the configuration accesses.

Follow the steps below to perform the applicable storage decoding:

1. Record the trace for NVMe, PQI, AHCI, ATA, SOP or SCSI device boot and decode it.

   This saves the configuration space and administration information in .xml format, which is used to decode traces that do not include configuration and administration commands.
2. Record the trace of the same NVMe, PQI, AHCI, ATA SOP or SCSI device without rebooting and the application will decode it.

You can keep recording and decoding until rebooting. On reboot repeat steps 1 and 2 above.

10.23.1 NVMe PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.39 on page 264 for NVMe PCIe SSD Device Configuration.

Prior to decoding, if all the required information is available in Configuration Space then the Source field in the PCIe SSD Configuration will be set to "Config Space" (see Figure 10.39 on page 264). The description for important fields and buttons are given below:

1. DEVICE ID: Represents the device ID in the bus/device/function address from the PCIe specification (ID Based routing).
2. DEVICENAME: Device Name

3. MBAR: The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box. The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
4. BAR2:
5. PROTOCOL: Displays the current storage protocol decoded.
6. ASQS: Defines the size of the Admin Submission Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Submission Queue is two entries. The maximum size of the Admin Submission Queue is 4096 entries. This is a 0's based value.
7. ACQS: Defines the size of the Admin Completion Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Completion Queue is two entries. The maximum size of the Admin Completion Queue is 4096 entries. This is a 0's based value.
8. DSTRD: This register indicates the stride between doorbell registers. The stride is specified in bytes. This may be used to separate doorbells by a number of bytes in memory space. It may be useful in software emulation of an NVMe Express controller. For hardware implementations of NVMe Express, the expected doorbell stride value is 4.
9. LBASIZE: Size for Logical Block Addressing.
10. MPS: This field indicates the host memory page in bytes.
11. IOCQES: I/O Completion Queue Entry Size. This field defines the I/O Completion Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
12. IOSQES: I/O Submission Queue Entry Size. This field defines the I/O Submission Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
13. MQES: Maximum Queue Entries Supported. Defines the maximum individual queue size that the controller supports. This is a 0's based value. The minimum value is 1h, indicating two entries.
14. Source: Source of the data.
15. Queues: Under this node the user can add more missing nodes to decode the current trace. Click the **Add Queue** or **Delete Queue** button to add or delete a queue node. Type based on the user selection.
16. XML Schema File Path: Selecting this link pops up a window with the location of the XML Schema File. It is also available in TechBrief_Use_of_NVMe_xml_schema.pdf in the installation AppNotes\ directory (or installation DVD).
17. Import Config Info: Click to Import configuration information.
18. Export Config Info: Click to Export configuration information.
19. Add Device/Delete Device: Click to add/delete device (NVMe/PQI only).

20. Add Queue/Delete Queue: Click to add/delete queue (NVMe/PQI only).
21. Add Namespace/Delete Namespace: Click to add/delete a new namespace if this information is not present in a trace file (NVMe/PQI only).
22. Interrupt Vector: Add/Delete an Interrupt Vector to a selected Device (see “Interrupts” on page 265).
23. Re-Decode: Click to re-decode.
24. Reset: Click to reset.
25. OK: Click to accept the settings.
26. Cancel: Click to cancel the settings.

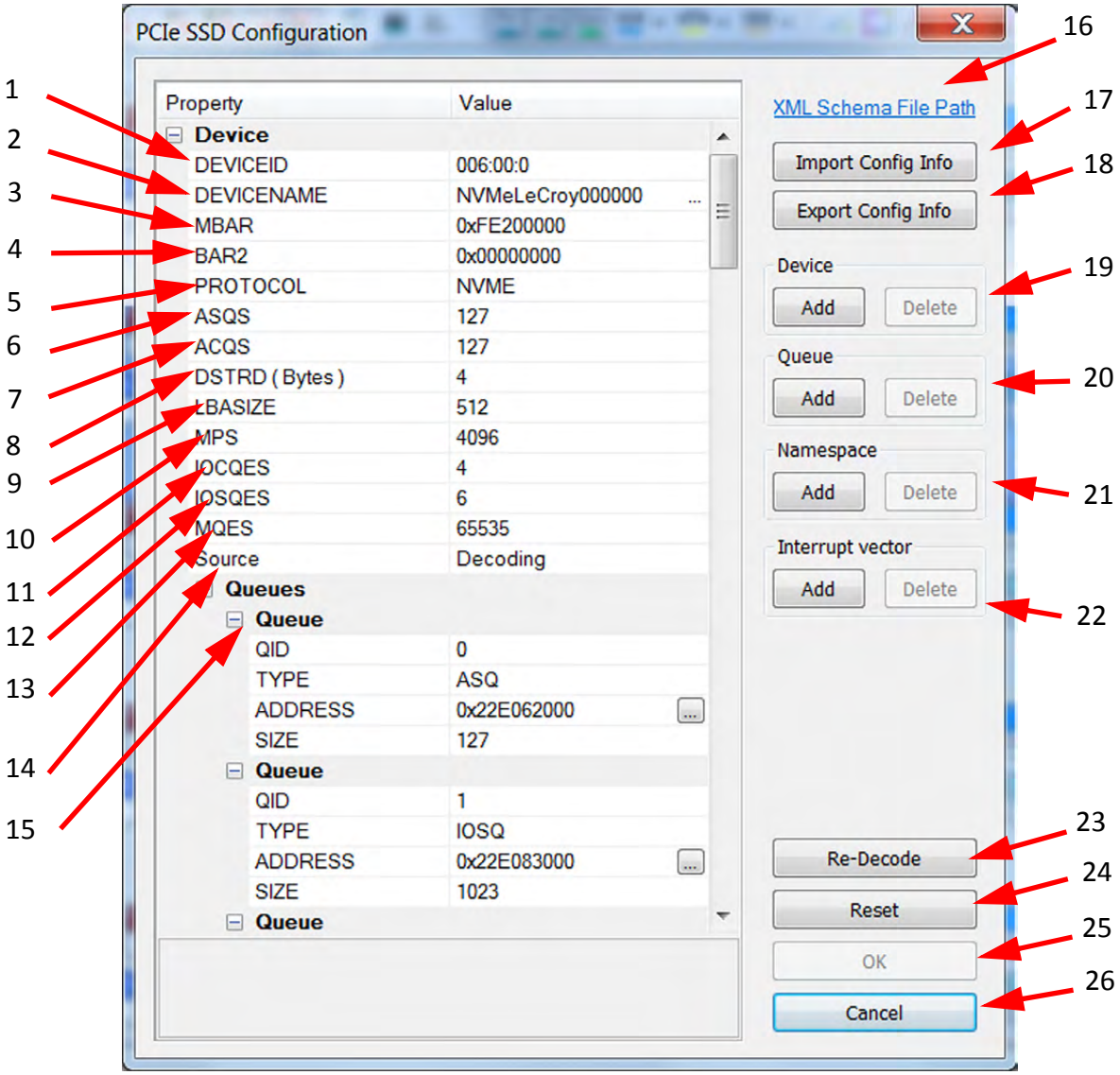


Figure 10.39: PCIe SSD Configuration Dialog Pre-decoding

Select any of the options in the NVM drop down menu item to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 10.41).

Note: When opening a trace file created with 7.0X or older versions of PCIe Protocol Suite, these new fields are not present and the application tries to export the configuration information to XML before decoding NVMe transaction level. In this case a message box will show claiming that a value for this field is required.

Note: In case of problems when opening older traces try the following: a) Decode NVMe transaction level before exporting XML file. This will apply the default value for the new fields and export can be performed. b) Manually enter the values for the new fields. c) In case the trace contains submission entries which are not decoded, add a new Queue and set the corresponding address in the PCIe SSD Configuration dialog.

Interrupts

MSI and MSI-x interrupts are decoded at configuration time and include the vector offset and address. These values can be added/deleted/modified by the user to add data that may not have been captured in the trace.

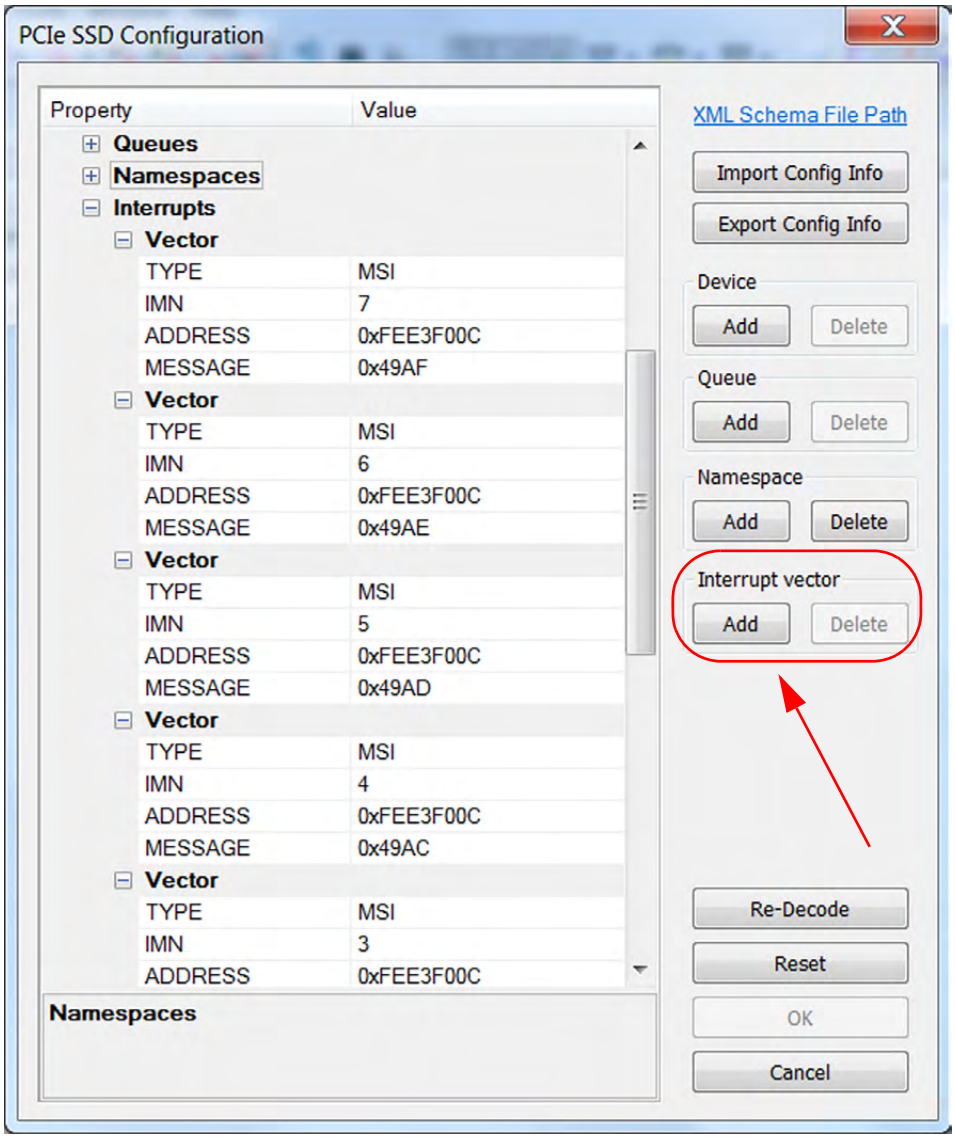


Figure 10.40: MSI and MSI-x Interrupts

Click

button to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 10.41 on page 266).

Note: When opening a trace file created with 7.0X or older versions of PCIe Protocol Suite, these new fields are not present and the application tries to export the configuration information to XML before decoding NVMe transaction level. In this case a message box will show claiming that a value for this field is required.

Note: In case of problems when opening older traces try the following: a) Decode NVMe transaction level before exporting XML file. This will apply the default value for the new fields and export can be performed. b) Manually enter the values for the new fields. c) In case the trace contains submission entries which are not decoded, add a new Queue and set the corresponding address in the PCIe SSD Configuration dialog.

10.23.2 AHCI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.41 for AHCI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.41).

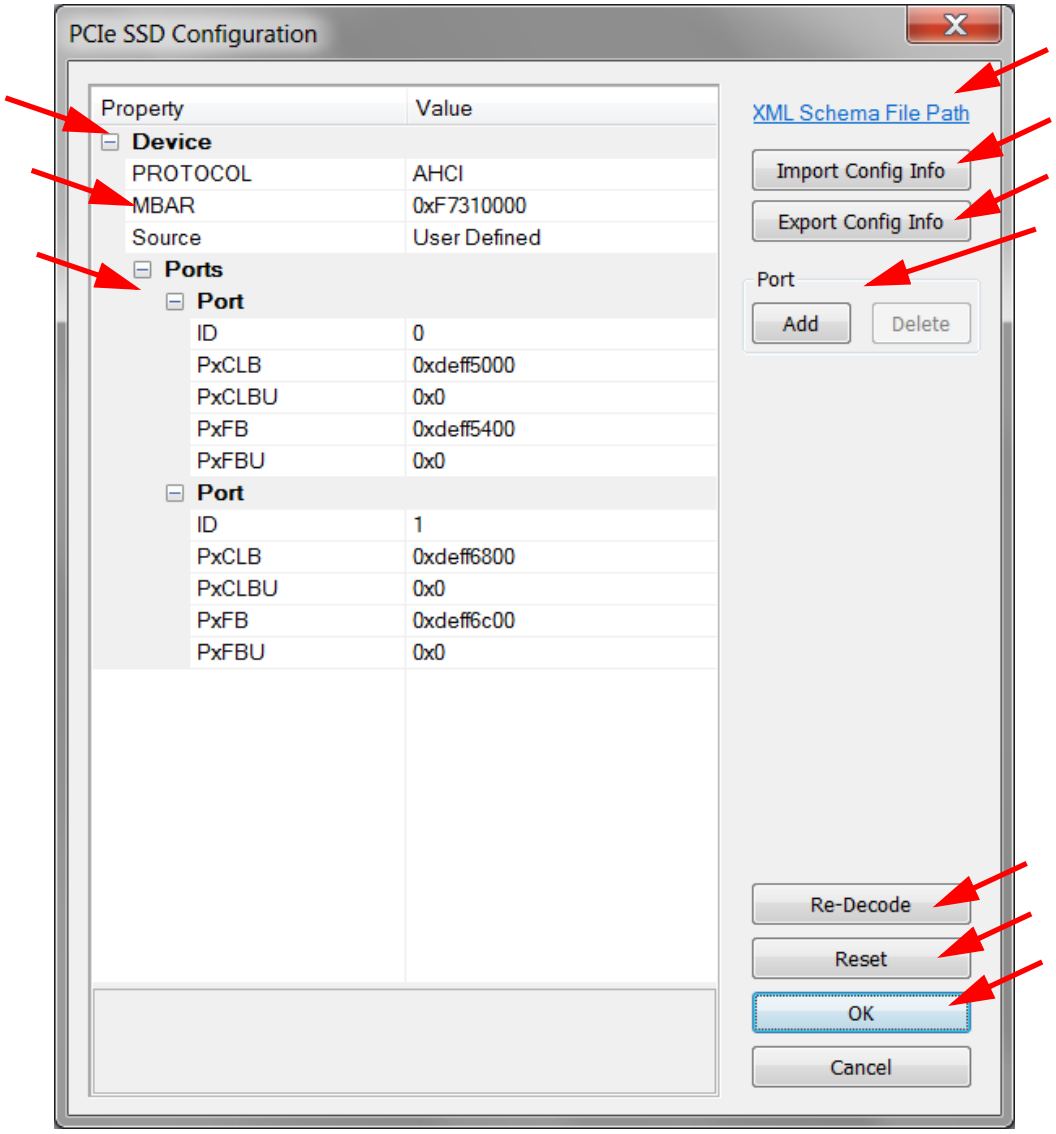


Figure 10.41: AHCI PCIe SSD Configuration Dialog

The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box (see Figure 10.43 on page 269). Some important fields are described below:

- Device: There is only one device node, (support for multiple device trace decoding will be available in a later release). If there is no device node, then the user can add a device node by clicking the **Add Device** button.
  - MBAR: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
- Ports: Under this node the user can add more missing nodes to decode the current trace. Click the **Add port** or **Delete Port** button to add or delete a port node. Enter CLB, CLBU and FB, FBU address fields. The address is 32 bit and should be in "0x" hex format. Please use the right value for size as it is an important attribute. Consult the AHCI specifications for the correct value.

Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click the **Import Config Info** button to import the configuration information as an .xml file, instead of adding it individually. Click the hyper-link **XML Schema File Path** to access the required format to generate the .xml file. This schema provides the detailed format for the imported file. All modern languages are equipped to generate an .xml file on a specific xml schema. The driver software accepts this schema and generates the .xml file with all the required information.

Click the **Export Config Info** button to export the configuration information as an .xml file.

Click the **Reset** button to reset the values to the original values. Press the **OK** button to save all the values.

10.23.3 PQI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.42 on page 268 for PQI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.42 on page 268).

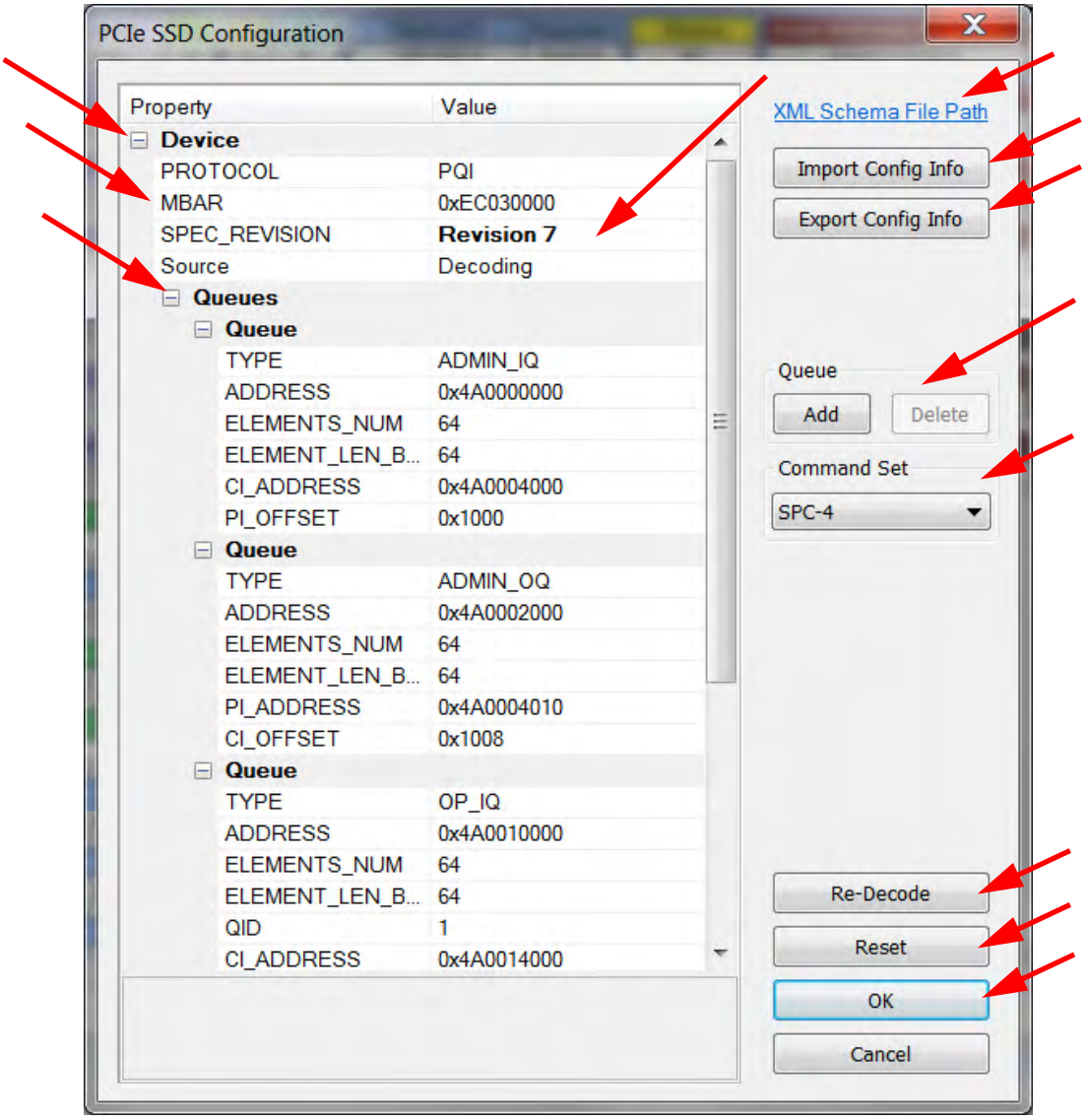


Figure 10.42: PQI PCIe SSD Configuration Dialog Pre-decoding

All the fields in this dialog are required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box see Figure 10.43 on page 269). Some important fields are described below:

- **Device**: There is only one device node, (support for multiple device trace decoding will be available in a later release). If there is no device node, then the user can add a device node by clicking the **Add Device** button. You can choose the spec revision from the drop down list.
- **MBAR**: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
- **Queues**: Under this node the user can add more missing nodes to decode the

current trace. Click the Add Queue or Delete Queue button to add or delete a queue node. Type based on the user selection. The following Node types are known.

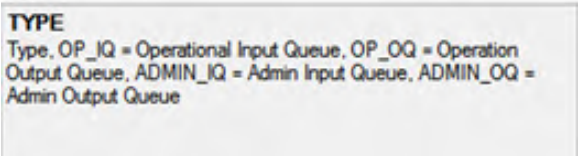

TYPE
Type, OP_IQ = Operational Input Queue, OP_OQ = Operation Output Queue, ADMIN_IQ = Admin Input Queue, ADMIN_OQ = Admin Output Queue

Figure 10.43: Node Types

The address is 64-bit and should be in "0x" hex format. Please use the right value for each size as it is an important attribute. Consult the NVMe specifications for the correct value. Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click PQI button to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 10.41 on page 266).

The two figures below show the BAR information for PQI and AHCI. If this information is present in the trace then it is not editable, otherwise it can be edited. Decoding is done only when configuration space and administration information is available.

Note: Only one device should be marked with the appropriate BAR, multiple BARs do not work.

10.23.4 SOP and SCSI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 10.44 on page 270 for SOP and SCSI PCIe SSD Device Configuration. T he base is the same as PQI Device Configuration but you can additionally choose the SCSI Command Set.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 10.44 on page 270).

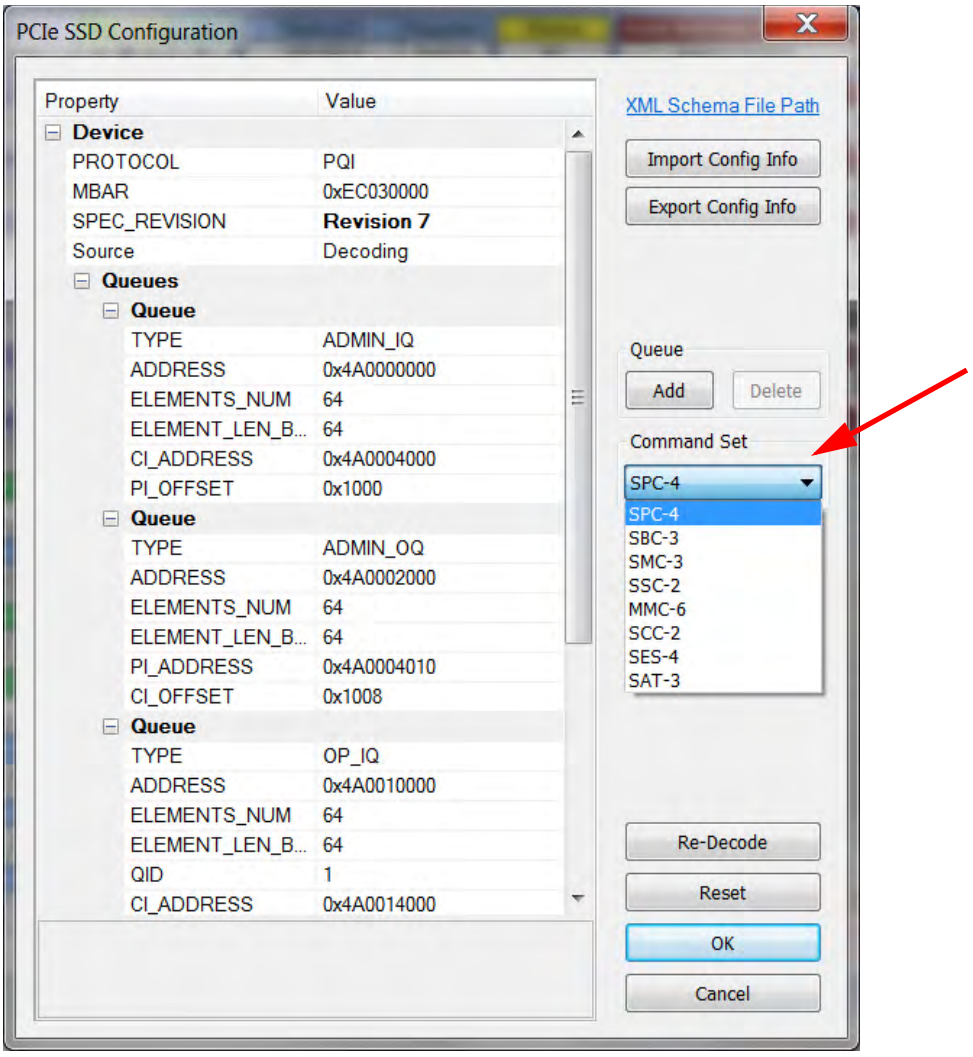


Figure 10.44: PCIe SSD Configuration Dialog - SOP and SCSI

See "Example of XML File Format for SSD Decodes" on page 309 for a template of the XML files.

10.24 Running Verification Scripts

You can run verification scripts to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs.

To display the Verification Script dialog (see Figure 10.45 on page 271), select **Tools > Run verification scripts**

or click the icon.

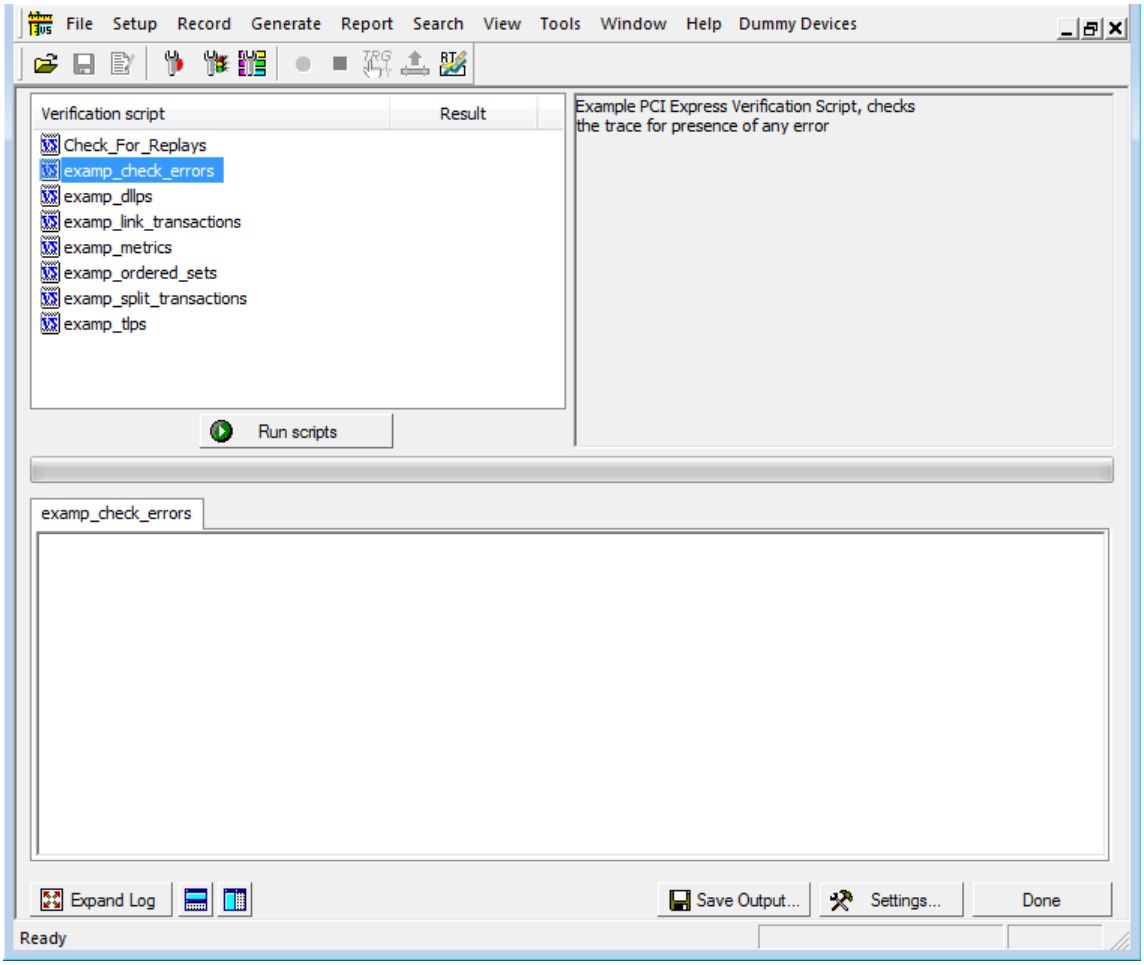
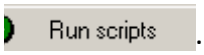


Figure 10.45: Verification Scripts Dialog

The available verification scripts are in the Verification script section.

To run a script, select it, then click the **Run Scripts** button 

.

The results appear in the bottom window. You can expand or collapse this window. You find a view related to the CATC Trace and place this window under or to the right of it. You can **Save** the results.

Click the **Settings** button to display the Settings Dialog (see Figure 10.46 on page 272).

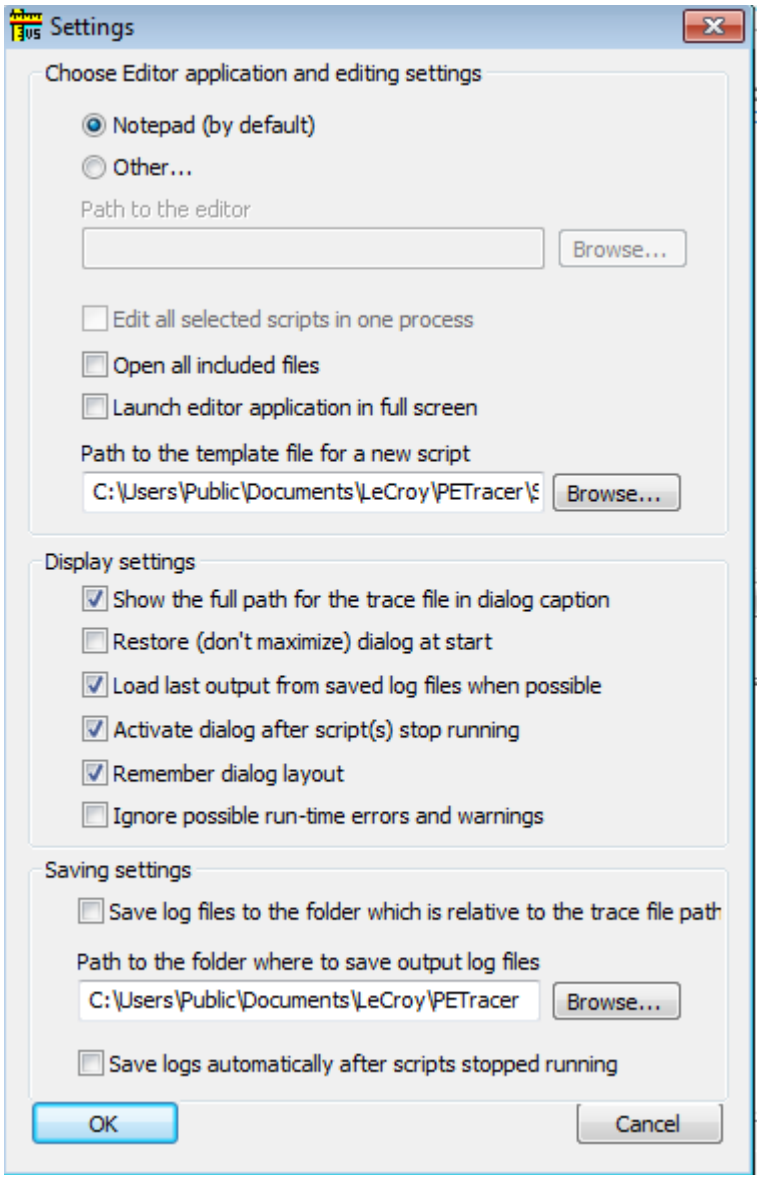

Settings
Choose Editor application and editing settings
Notepad (by default)
Other...
Path to the editor
Browse...
Edit all selected scripts in one process
Open all included files
Launch editor application in full screen
Path to the template file for a new script
C:\Users\Public\Documents\LeCroy\PETracer\S
Browse...
Display settings
Show the full path for the trace file in dialog caption
Restore (don't maximize) dialog at start
Load last output from saved log files when possible
Activate dialog after script(s) stop running
Remember dialog layout
Ignore possible run-time errors and warnings
Saving settings
Save log files to the folder which is relative to the trace file path
Path to the folder where to save output log files
C:\Users\Public\Documents\LeCroy\PETracer
Browse...
Save logs automatically after scripts stopped running
OK
Cancel

Figure 10.46: Settings Dialog

You can choose the editor, display settings, and saving settings.

10.24.1NVMe Performance: Doorbell Timing

You can run verification scripts to determine Doorbell performance, see Figure 10.47.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,
  (time from submission command to command completion

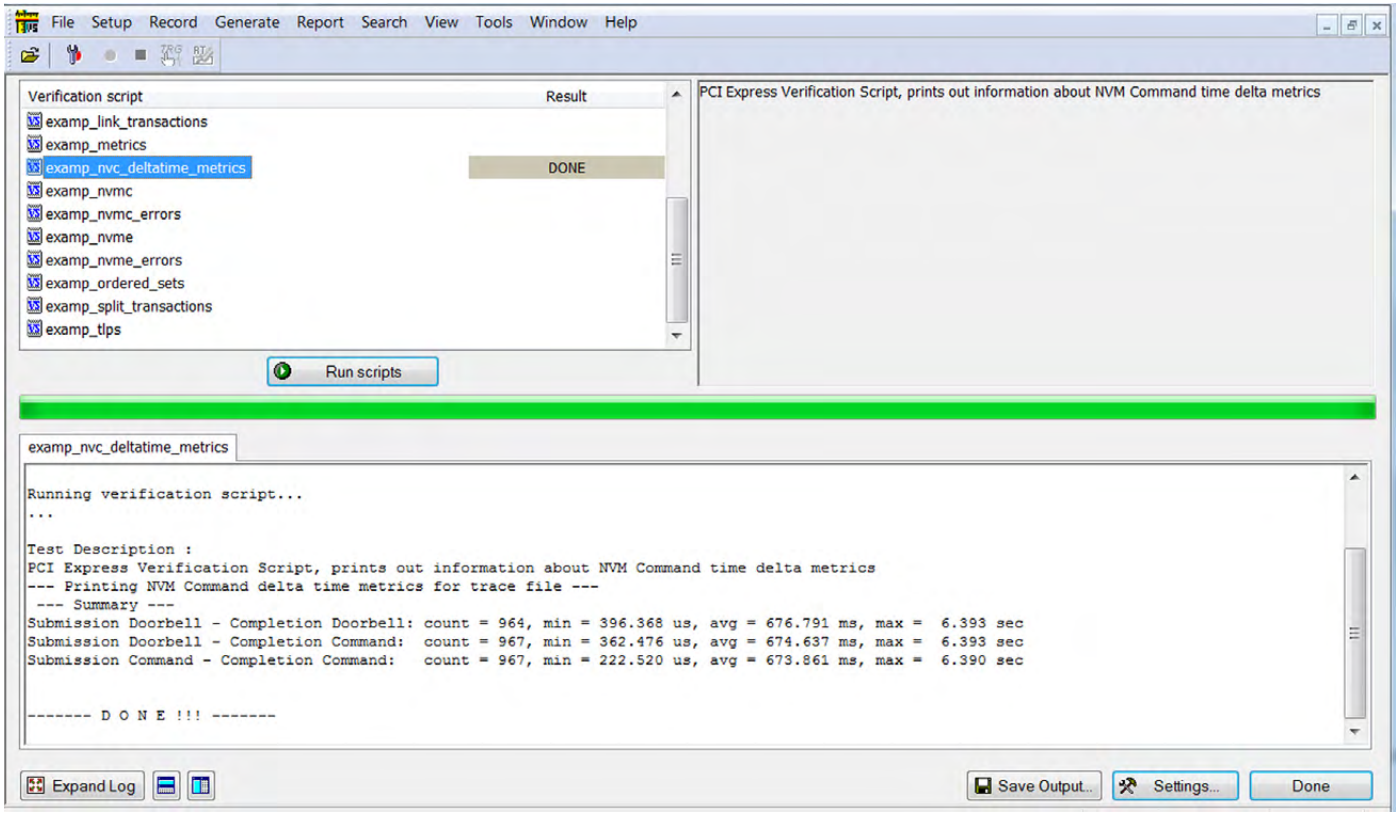

File Setup Record Generate Report Search View Tools Window Help
Verification script
Result
examp_link_transactions
examp_metrics
examp_nvc_deltatime_metrics
DONE
examp_nvmc
examp_nvmc_errors
examp_nvme
examp_nvme_errors
examp_ordered_sets
examp_split_transactions
examp_tlps
PCI Express Verification Script, prints out information about NVM Command time delta metrics
Run scripts
examp_nvc_deltatime_metrics
Running verification script...
...
Test Description :
PCI Express Verification Script, prints out information about NVM Command time delta metrics
--- Printing NVM Command delta time metrics for trace file ---
--- Summary ---
Submission Doorbell - Completion Doorbell: count = 964, min = 396.368 us, avg = 676.791 ms, max = 6.393 sec
Submission Doorbell - Completion Command: count = 967, min = 362.476 us, avg = 674.637 ms, max = 6.393 sec
Submission Command - Completion Command: count = 967, min = 222.520 us, avg = 673.861 ms, max = 6.390 sec
------- D O N E !!! -------
Expand Log
Save Output...
Settings...
Done

Figure 10.47: NVMe Performance Script Verification

10.25 Trace Expert

Trace Expert is a reporting tool that is used to create a portable, customized summary and report of a PCI express trace. The generated report groups the selected data and statistics into four groups:

- Performance Analysis
- Trace Analysis Statistics
- Error Reports
- Trace File Information

After a Trace has been loaded, Trace Expert is available from the Main Toolbar as shown in Figure 10.48.

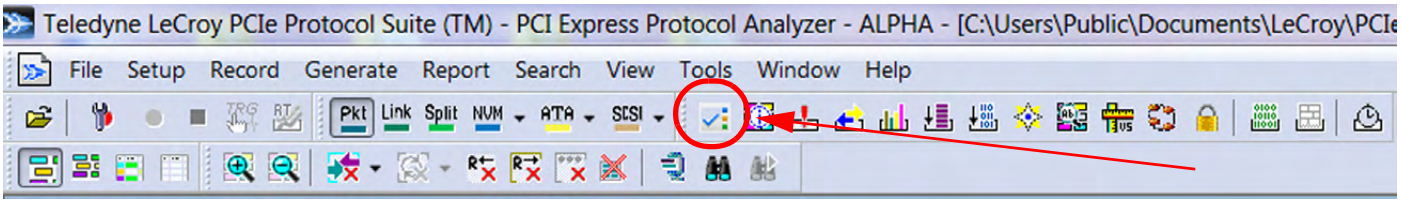

Teledyne LeCroy PCIe Protocol Suite (TM) - PCI Express Protocol Analyzer - ALPHA - [C:\Users\Public\Documents\LeCroy\PCIe
File Setup Record Generate Report Search View Tools Window Help
Pkt Link Split NVM ATA SCSI

Figure 10.48: Main Toolbar: Trace Expert

To launch the Trace Expert dialog click on the icon. Different report sections can be selected for inclusion into the final report using the dialog. The path where the report will be generated can be set at the bottom of the dialog (see Figure 10.49). Any additional decoding required to generate the report will be done automatically.

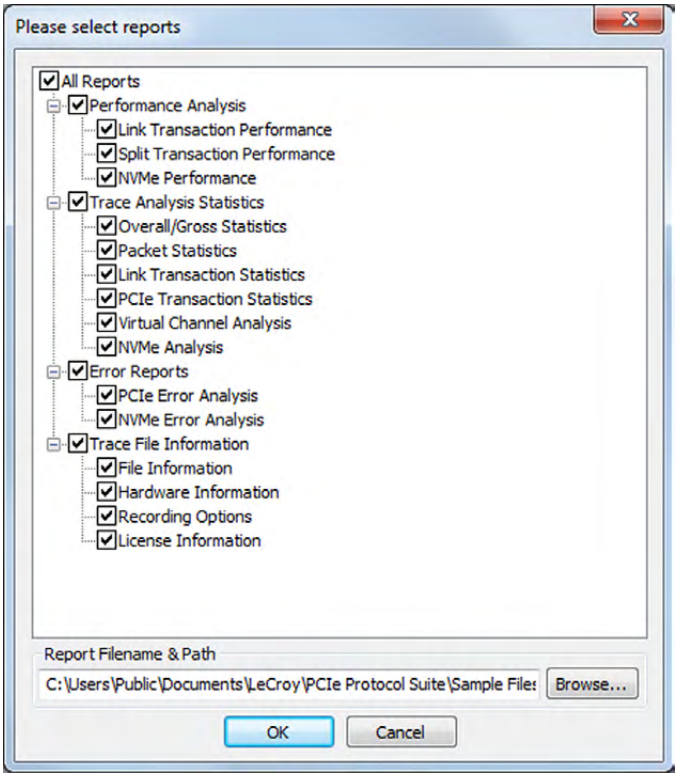


Figure 10.49: Trace Expert Report Types and Path

The generated report (see Figure 10.50) has sections which can be expanded to show the associated data. The generated file is self-contained and portable so it can be safely emailed or archived. It will open automatically in the default browser once it is successfully generated. Icons on the top right can be used to:

- Save All (Saves to User's Download folder)
- Expand All
- Collapse All
- Print All of the currently displayed view.

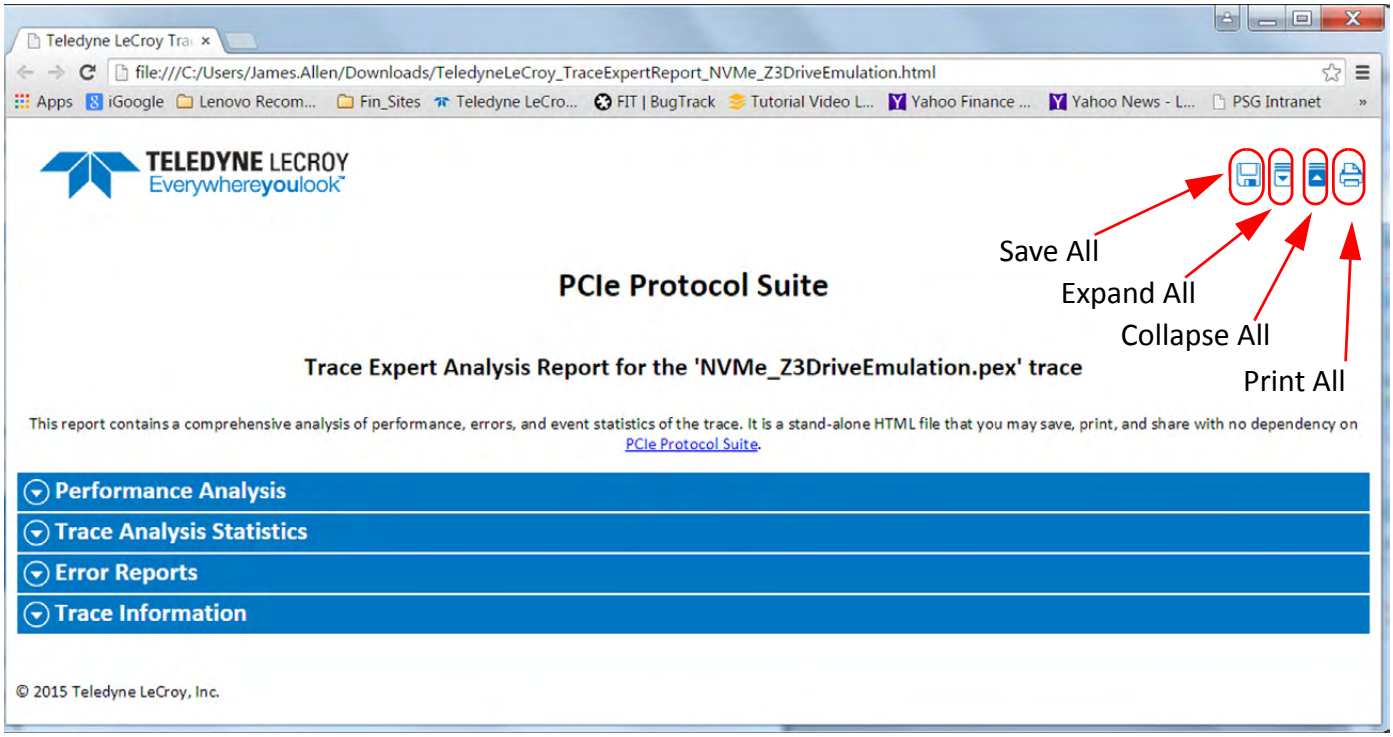
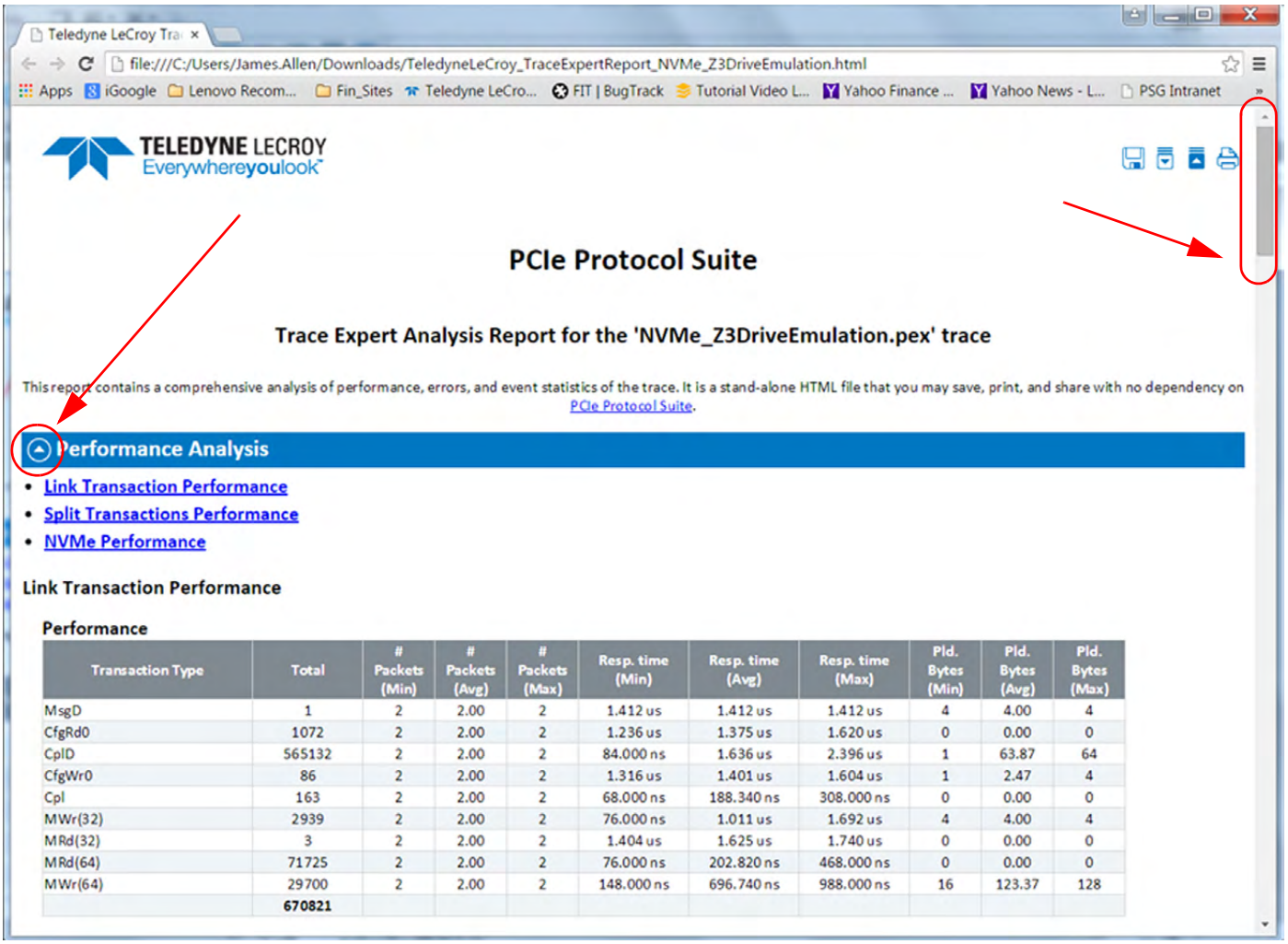


Figure 10.50: Trace Expert Main Menu

Select Performance Analysis to bring up the respective dialog (see Figure 10.51 on page 276):

10.25.1 Performance Analysis



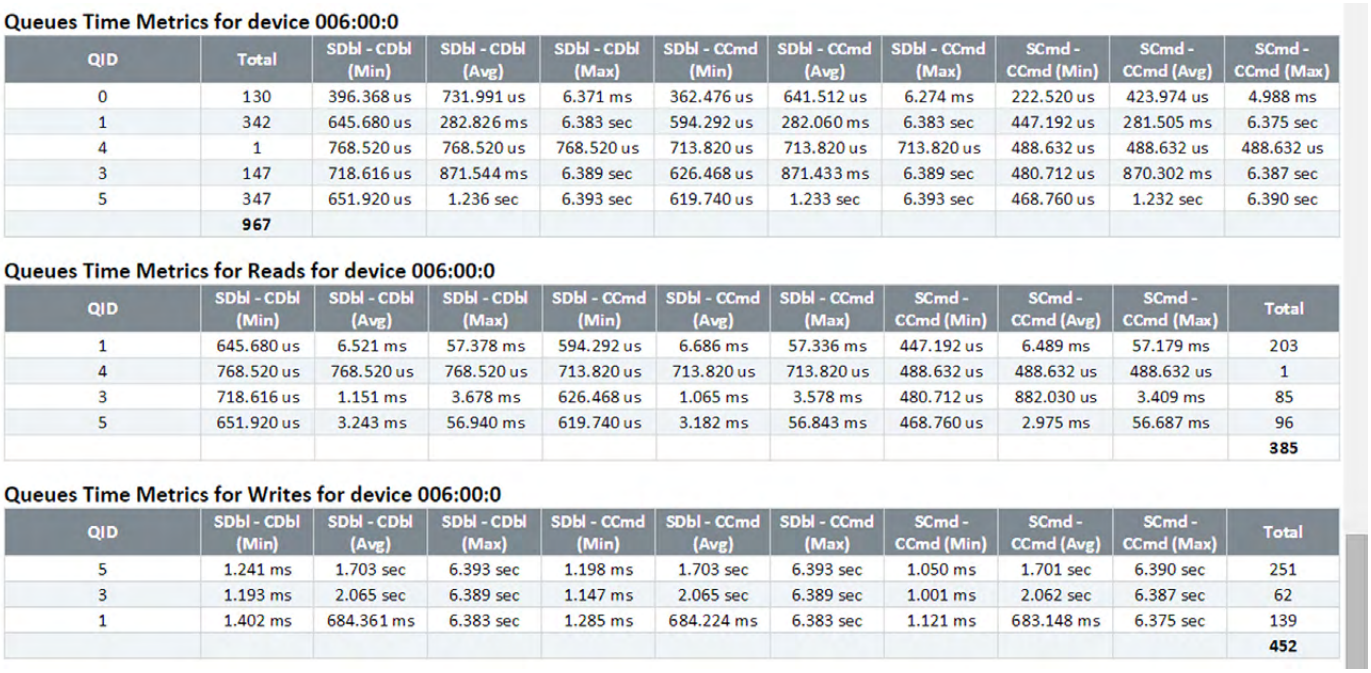
Transaction Type	Total	# Packets (Min)	# Packets (Avg)	# Packets (Max)	Resp. time (Min)	Resp. time (Avg)	Resp. time (Max)	Pld. Bytes (Min)	Pld. Bytes (Avg)	Pld. Bytes (Max)
MsgD	1	2	2.00	2	1.412 us	1.412 us	1.412 us	4	4.00	4
CfgRd0	1072	2	2.00	2	1.236 us	1.375 us	1.620 us	0	0.00	0
CplD	565132	2	2.00	2	84.000 ns	1.636 us	2.396 us	1	63.87	64
CfgWr0	86	2	2.00	2	1.316 us	1.401 us	1.604 us	1	2.47	4
Cpl	163	2	2.00	2	68.000 ns	188.340 ns	308.000 ns	0	0.00	0
MWr(32)	2939	2	2.00	2	76.000 ns	1.011 us	1.692 us	4	4.00	4
MRd(32)	3	2	2.00	2	1.404 us	1.625 us	1.740 us	0	0.00	0
MRd(64)	71725	2	2.00	2	76.000 ns	202.820 ns	468.000 ns	0	0.00	0
MWr(64)	29700	2	2.00	2	148.000 ns	696.740 ns	988.000 ns	16	123.37	128
	670821									

Figure 10.51: Trace Expert - Performance Analysis

You can scroll down to see the other reports.

NVMe Performance

Queue Time Metrics are shown under NVMe Performance. See Figure 10.52.



Queues Time Metrics for device 006:00:0

QID	Total	SDbl - CDbl (Min)	SDbl - CDbl (Avg)	SDbl - CDbl (Max)	SDbl - CCmd (Min)	SDbl - CCmd (Avg)	SDbl - CCmd (Max)	SCmd - CCmd (Min)	SCmd - CCmd (Avg)	SCmd - CCmd (Max)
0	130	396.368 us	731.991 us	6.371 ms	362.476 us	641.512 us	6.274 ms	222.520 us	423.974 us	4.988 ms
1	342	645.680 us	282.826 ms	6.383 sec	594.292 us	282.060 ms	6.383 sec	447.192 us	281.505 ms	6.375 sec
4	1	768.520 us	768.520 us	768.520 us	713.820 us	713.820 us	713.820 us	488.632 us	488.632 us	488.632 us
3	147	718.616 us	871.544 ms	6.389 sec	626.468 us	871.433 ms	6.389 sec	480.712 us	870.302 ms	6.387 sec
5	347	651.920 us	1.236 sec	6.393 sec	619.740 us	1.233 sec	6.393 sec	468.760 us	1.232 sec	6.390 sec
	967									

Queues Time Metrics for Reads for device 006:00:0

QID	SDbl - CDbl (Min)	SDbl - CDbl (Avg)	SDbl - CDbl (Max)	SDbl - CCmd (Min)	SDbl - CCmd (Avg)	SDbl - CCmd (Max)	SCmd - CCmd (Min)	SCmd - CCmd (Avg)	SCmd - CCmd (Max)	Total
1	645.680 us	6.521 ms	57.378 ms	594.292 us	6.686 ms	57.336 ms	447.192 us	6.489 ms	57.179 ms	203
4	768.520 us	768.520 us	768.520 us	713.820 us	713.820 us	713.820 us	488.632 us	488.632 us	488.632 us	1
3	718.616 us	1.151 ms	3.678 ms	626.468 us	1.065 ms	3.578 ms	480.712 us	882.030 us	3.409 ms	85
5	651.920 us	3.243 ms	56.940 ms	619.740 us	3.182 ms	56.843 ms	468.760 us	2.975 ms	56.687 ms	96
										385

Queues Time Metrics for Writes for device 006:00:0

QID	SDbl - CDbl (Min)	SDbl - CDbl (Avg)	SDbl - CDbl (Max)	SDbl - CCmd (Min)	SDbl - CCmd (Avg)	SDbl - CCmd (Max)	SCmd - CCmd (Min)	SCmd - CCmd (Avg)	SCmd - CCmd (Max)	Total
5	1.241 ms	1.703 sec	6.393 sec	1.198 ms	1.703 sec	6.393 sec	1.050 ms	1.701 sec	6.390 sec	251
3	1.193 ms	2.065 sec	6.389 sec	1.147 ms	2.065 sec	6.389 sec	1.001 ms	2.062 sec	6.387 sec	62
1	1.402 ms	684.361 ms	6.383 sec	1.285 ms	684.224 ms	6.383 sec	1.121 ms	683.148 ms	6.375 sec	139
										452

Figure 10.52: NVMe Performance: Queue Time Metrics

10.25.2 Trace Analysis Statistics

Selecting Trace Analysis Statistics will produce the following reports:

- Overall/Gross Statistics
- Packet Statistics
- Link Transaction Analysis
- PCIe Transfer Analysis
- Virtual Channel Analysis
- NVMe Analysis
- SATA-Express Analysis

See Figure 10.53 on page 278.

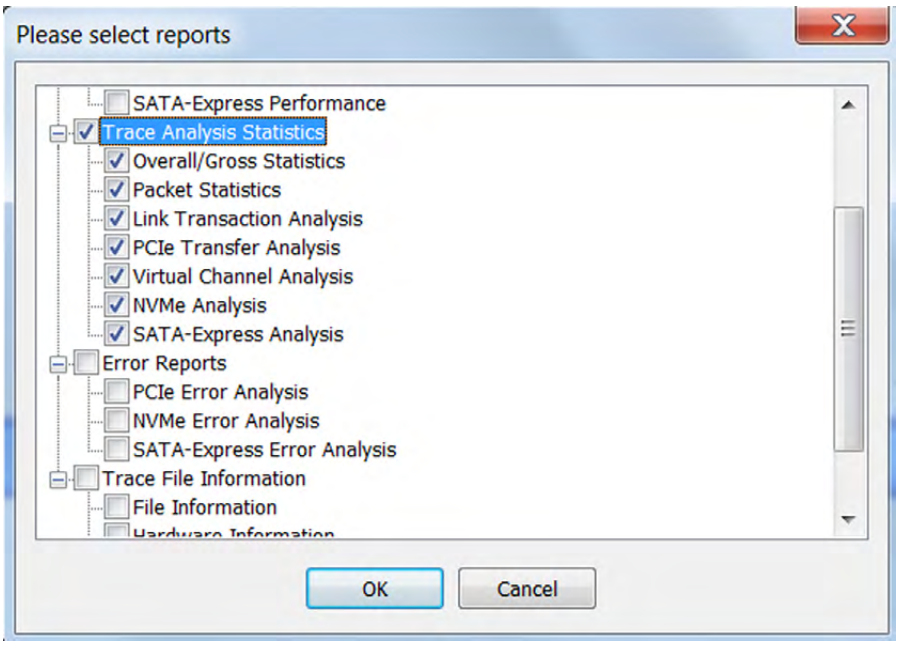


Figure 10.53: Trace Expert: Trace Analysis Statistics Reports

Selecting specific reports and clicking on OK will bring up the following dialog (see Figure 10.54 on page 279):

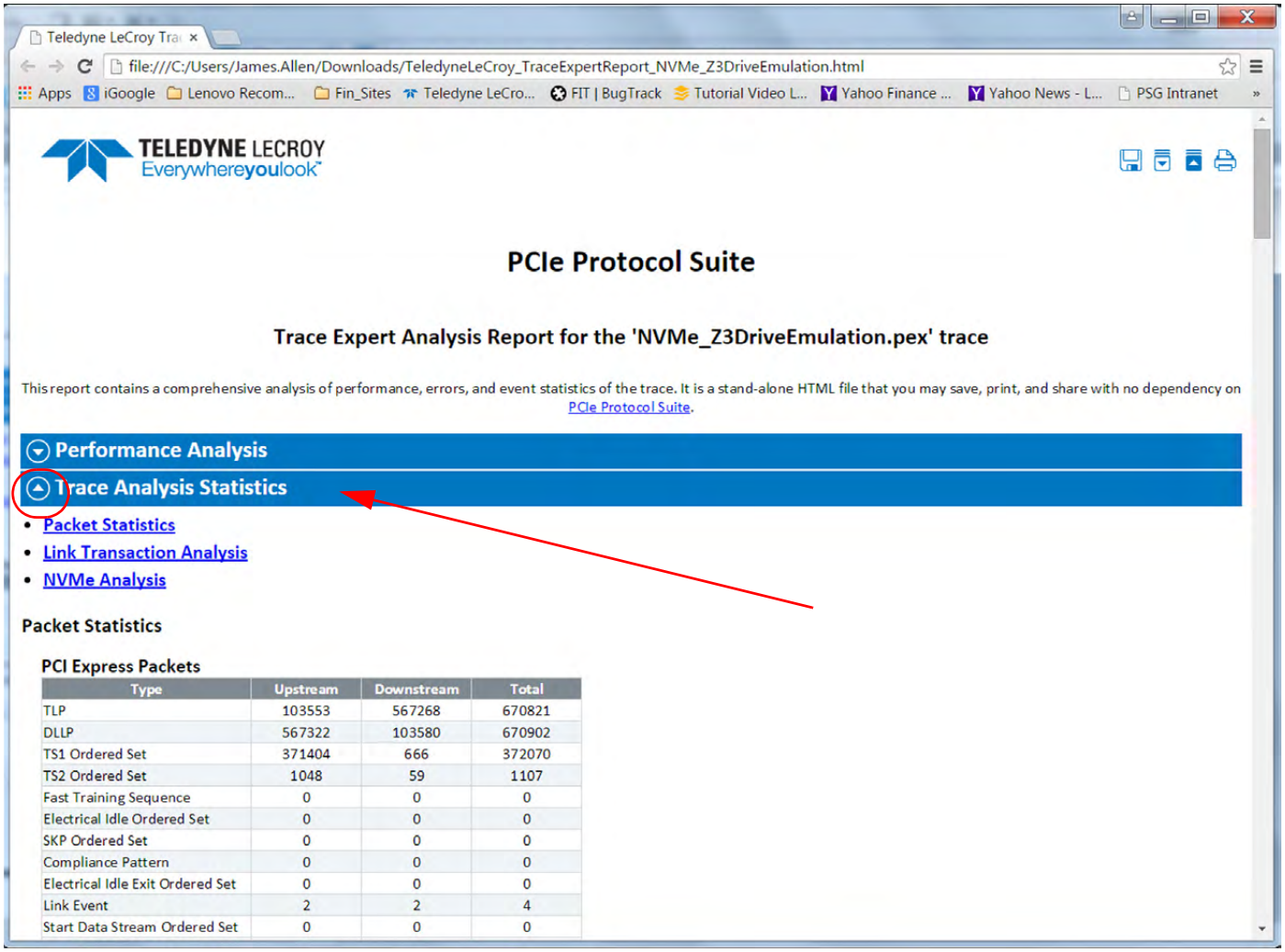

Teledyne LeCroy Tra
file:///C:/Users/James.Allen/Downloads/TeledyneLeCroy_TraceExpertReport_NVMe_Z3DriveEmulation.html
Apps
iGoogle
Lenovo Recom...
Fin_Sites
Teledyne LeCro...
FIT | BugTrack
Tutorial Video L...
Yahoo Finance ...
Yahoo News - L...
PSG Intranet
TELEDYNE LECROY
Everywhereyoulook
PCIe Protocol Suite
Trace Expert Analysis Report for the 'NVMe_Z3DriveEmulation.pex' trace
This report contains a comprehensive analysis of performance, errors, and event statistics of the trace. It is a stand-alone HTML file that you may save, print, and share with no dependency on PCIe Protocol Suite.
Performance Analysis
Trace Analysis Statistics
Packet Statistics
Link Transaction Analysis
NVMe Analysis
Packet Statistics
PCI Express Packets
Type Upstream Downstream Total
TLP 103553 567268 670821
DLLP 567322 103580 670902
TS1 Ordered Set 371404 666 372070
TS2 Ordered Set 1048 59 1107
Fast Training Sequence 0 0 0
Electrical Idle Ordered Set 0 0 0
SKP Ordered Set 0 0 0
Compliance Pattern 0 0 0
Electrical Idle Exit Ordered Set 0 0 0
Link Event 2 2 4
Start Data Stream Ordered Set 0 0 0

Figure 10.54: Trace Expert: Trace Analysis Statistics: Packet Statistics

You can scroll down to see the other reports and analysis.

10.25.3 Error Reports

Selecting Error Reports generates the following reports:

- PCIe Error Analysis
- NVMe Error Analysis
- SATA-Express Error Analysis

See Figure 10.55 on page 280.

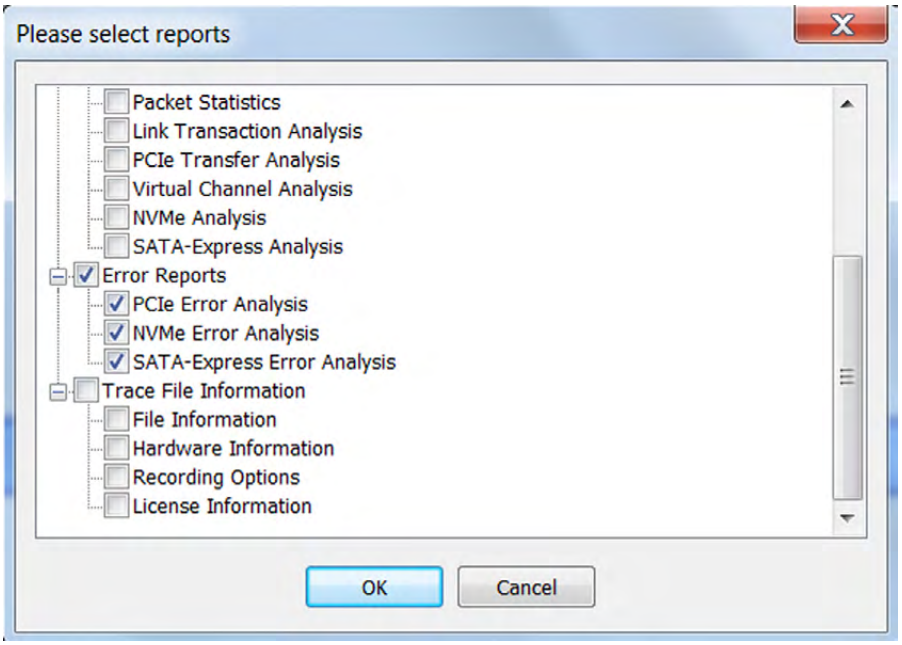


Figure 10.55: Trace Analysis: Error Reports

Selecting specific reports and clicking OK will bring up the following dialog (see Figure 10.56):

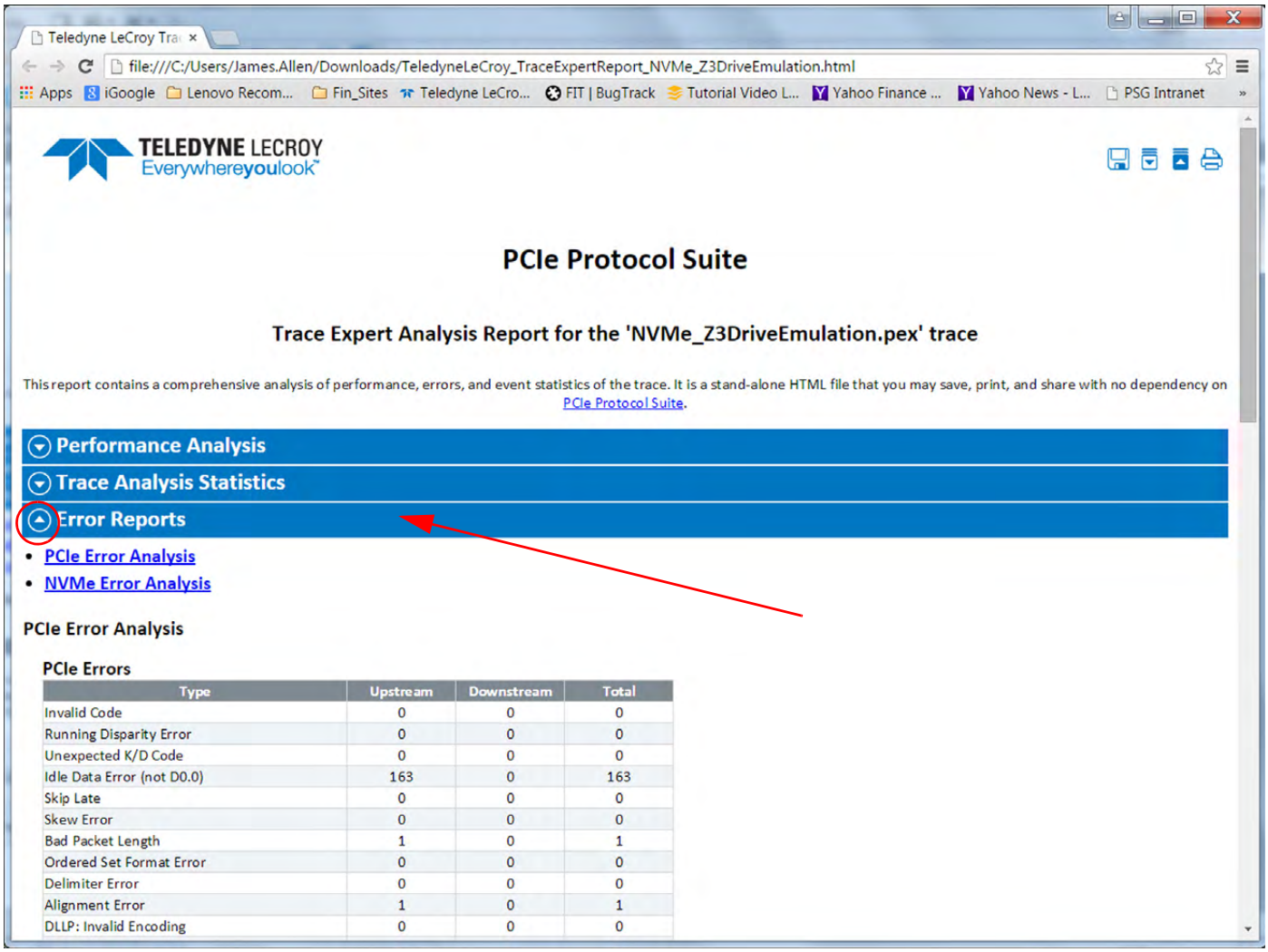

Teledyne LeCroy Tra
file:///C:/Users/James.Allen/Downloads/TeledyneLeCroy_TraceExpertReport_NVMe_Z3DriveEmulation.html
Apps
iGoogle
Lenovo Recom...
Fin_Sites
Teledyne LeCro...
FIT | BugTrack
Tutorial Video L...
Yahoo Finance ...
Yahoo News - L...
PSG Intranet
TELEDYNE LECROY
Everywhereyoulook™
PCIe Protocol Suite
Trace Expert Analysis Report for the 'NVMe_Z3DriveEmulation.pex' trace
This report contains a comprehensive analysis of performance, errors, and event statistics of the trace. It is a stand-alone HTML file that you may save, print, and share with no dependency on PCIe Protocol Suite.
Performance Analysis
Trace Analysis Statistics
Error Reports
PCIe Error Analysis
NVMe Error Analysis
PCIe Error Analysis
PCIe Errors
Type Upstream Downstream Total
Invalid Code 0 0 0
Running Disparity Error 0 0 0
Unexpected K/D Code 0 0 0
Idle Data Error (not D0.0) 163 0 163
Skip Late 0 0 0
Skew Error 0 0 0
Bad Packet Length 1 0 1
Ordered Set Format Error 0 0 0
Delimiter Error 0 0 0
Alignment Error 1 0 1
DLLP: Invalid Encoding 0 0 0

Figure 10.56: Trace Expert: Error Reports

You can scroll down to see the other reports and analysis.

10.25.4 Trace File Information

Selecting Trace File Information will generate the following reports:

- File Information
- Hardware Information
- Recording Options
- License Information

See Figure 10.57 on page 282.

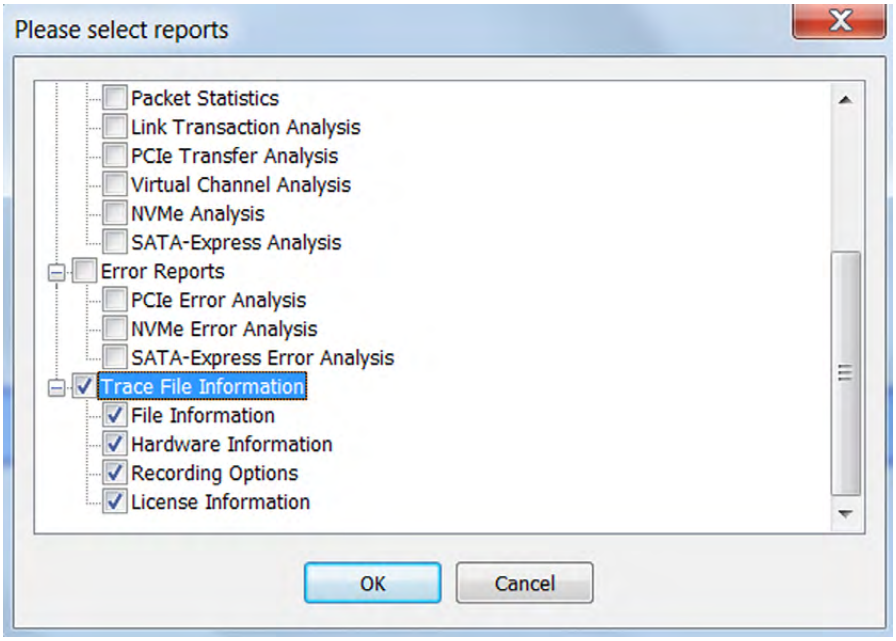


Figure 10.57: Trace Expert: Trace File Information

Selecting specific reports and clicking on OK will bring up the following dialog (see Figure 10.58 on page 283):

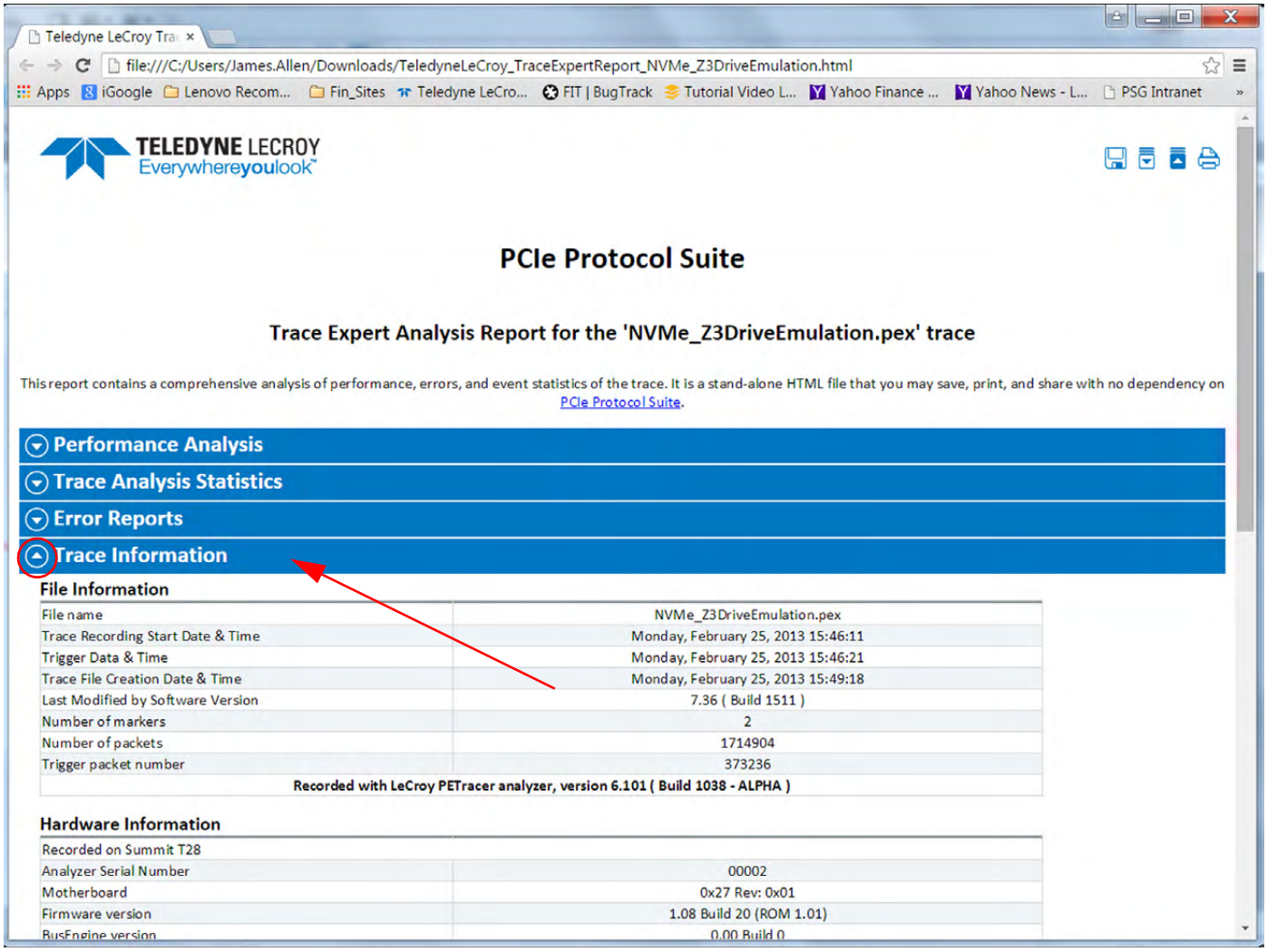

Teledyne LeCroy Tra
file:///C:/Users/James.Allen/Downloads/TeledyneLeCroy_TraceExpertReport_NVMe_Z3DriveEmulation.html
Apps
iGoogle
Lenovo Recom...
Fin_Sites
Teledyne LeCro...
FIT | BugTrack
Tutorial Video L...
Yahoo Finance ...
Yahoo News - L...
PSG Intranet
TELEDYNE LECROY
Everywhereyoulook™
PCIe Protocol Suite
Trace Expert Analysis Report for the 'NVMe_Z3DriveEmulation.pex' trace
This report contains a comprehensive analysis of performance, errors, and event statistics of the trace. It is a stand-alone HTML file that you may save, print, and share with no dependency on PCIe Protocol Suite.
Performance Analysis
Trace Analysis Statistics
Error Reports
Trace Information
File Information
File name NVMe_Z3DriveEmulation.pex
Trace Recording Start Date & Time Monday, February 25, 2013 15:46:11
Trigger Data & Time Monday, February 25, 2013 15:46:21
Trace File Creation Date & Time Monday, February 25, 2013 15:49:18
Last Modified by Software Version 7.36 (Build 1511)
Number of markers 2
Number of packets 1714904
Trigger packet number 373236
Recorded with LeCroy PETracer analyzer, version 6.101 (Build 1038 - ALPHA)
Hardware Information
Recorded on Summit T28
Analyzer Serial Number 00002
Motherboard 0x27 Rev: 0x01
Firmware version 1.08 Build 20 (ROM 1.01)
BusEngine version 0.00 Build 0

Figure 10.58: Trace Expert: Trace Information

Scroll down to see the other reports and information.

Chapter 11

Updates and Licensing

11.1 Updating the Analyzer

BusEngine™ and/or Firmware updates are now automatic processes that run anytime a new version of the PCIe Protocol Suite™ software is installed that is incompatible with the currently installed BusEngine or Firmware. The update process generates on-screen instructions.

If, however, you need to manually perform BusEngine or Firmware updates, follow these steps:

1. Select **Setup > Update Device** … from the menu to display the Update Analyzer dialog box for **Summit T24™.**
2. Select the appropriate file locations for the Firmware and/or BusEngine, using Browse, if necessary.
3. Check the appropriate options (if in doubt, check all options).
4. Click **Update** to initiate the updating of the Analyzer.

11.2 License Keys

A License Key is necessary to enable software maintenance. If you attempt to record with the Analyzer without an installed License Key, a message appears to indicate that a License Key is necessary in order to record traffic.

A License Key must be obtained from Teledyne LeCroy for each Analyzer.

After you obtain the License Key, follow these steps to install it:

1. Select **Setup > All Connected Devices** and click the **Update License** button to display the Select License Key File dialog box.
2. Enter the **path** and **filename** for the License Key or use the Browse button to navigate to the directory that contains the License Key.
3. Select the **.lic** file, and then click **Open**.

11.3 License Information

You can view Licensing information for your Analyzer by selecting **Help > Display License Information**... from the menu bar. The License Information window displays data about the maintenance expiration and purchased features.

Appendix A

Configuration Space Decoding

The decoded capability structures in the Configuration Space Viewer and Editor are based on programmed definitions in the PCIe Protocol Suite software and on Configuration Space Decode Scripts.

Configuration Space Decode Scripts are tools to define capability structures and instruct the Configuration Space Viewer or Editor how to decode them. These scripts are in the **\CfgSpaceScripts** sub-directory below the **\Scripts** directory in the application directory.

You can write Configuration Space Decode Scripts using the CATC Scripting Language (CSL). See the *Teledyne LeCroy Analyzers File Based Decoding Manual* for reference.

PCI Express Configuration Space Decode Scripts have the file extension **.pecfgdec**.

12.1 Mandatory Definitions

Configuration Space Decode Scripts must set the following reserved variables.

- **CapabilityName**: Name of the capability structure
- **CapabilityID**: ID of the capability structure
- **ExtAddSpace**: Set to 1 if Extended Configuration Space. Else, set to 0 for PCI.

12.2 Mandatory Module Functions

Modules are collections of functions and data dedicated to decoding a specific capability structure. Each module has one primary Configuration Space Decode Script file (extension **.pecfgdec**) and optionally has include files (**.inc**).

A module function is an entry-point into a decoding module. To help display a capability structure, the application calls a module function.

The Configuration Space Editor and Viewer support only the **DecodeRegister(offset)** and **GetSize( )** functions.

12.2.1 DecodeRegister()

DecodeRegister(offset)

The application calls this function while decoding a specific DWORD offset of the specified CapabilityID. The offset is the decoding entry point, where the decoding path starts.

The Configuration Space Editor calls this function to determine how to decode the assigned configuration space. The **offset** parameter is the DWORD to decode.
An offset of 0 indicates bytes 00h-03h, an offset of 1 indicates bytes 04h-07h, and so on.

Note: The Configuration Space Editor can only decode one DWORD at a time.

12.2.2 GetSize()

This function returns the size of the capability structure specified by CapabilityID.

12.3 Configuration Register Types

The following reserved variables are defined global constants.

- CFGREG_UNDEFINED
- CFGREG_HWINIT
- CFGREG_RO
- CFGREG_RW
- CFGREG_RW1C
- CFGREG_ROS
- CFGREG_RWS
- CFGREG_RW1CS
- CFGREG_RSVDP
- CFGREG_RSVDZ

Note: These reserved variables match the Configuration Register Types of Table 7-2 in Section 7.4 of the PCI Express Base Specification, Rev. 2.1.

12.4 Primitives

Decoding uses the following primitives.

12.4.1 GetRegisterField()

GetRegisterField(dword_offset, bit_offset, field_length)

This function returns a register field of length **field_length**, starting at bit position **bit_offset** in DWORD **dword_offset**.

- **dword_offset**: DWORD offset of the register field location
- **bit_offset**: Bit offset of the register field location
- **field_length**: Length of the register field

For example, **GetRegisterField(1, 9, 2);** means: Go to DWORD 1, bit offset 9, and returns 2 bits.

12.4.2 AddField()

AddField(field_name, field_length, configuration_reg_type, tooltip, encoding_table = NULL)

This function adds a register field to the Capability View and returns a pointer to the field, for adding subfields.

- **field_name**: Name of the register field to display in the Capability View
- **field_length**: Length of the register field
- **configuration_reg_type**: Configuration register type of the register field. Note: If subfields are defined, their configuration register types override this setting for their specified bits.
- **tooltip**: Tooltip displayed for the register field in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

As examples:
AddField("PCI Express Extended Capability ID", 16, CFGREG_RO, "");
means: Add the field “PCI Express Extended Capability ID” with length 16 and cfg register type CFGREG_RO.

capability_reg = AddField("Capability Register", 32, CFGREG_RW, "");
means: Added the field “Capability Register” with length 32 and cfg register type CFGREG_RW and stored a pointer to this field in variable capability_reg, which can be used to add subfields to this field.

12.4.3 AddSubField()

AddSubField(parent_field, subfield_name, subfield_length, configuration_reg_type, tooltip, encoding_table = NULL);

This function adds a subfield to a register field in the Capability View. Subfields are modifiable and visible in the Field View and appear in the tooltips of register fields.

- **parent_field**: Pointer to a register field in the Capability View
- **subfield_name**: Name of the subfield, displayed in the Field View
- **subfield_length**: Length of the subfield
- **configuration_reg_type**: Configuration register type of the subfield field. Note: This overrides the configuration_reg_type of the parent field.
- **tooltip**: Tooltip displayed for the subfield in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

For example,
AddSubField(capability_reg, "Mode Supported", 4, CFGREG_RO, "Indicates the Function modes,"), ModeEncodings);
means: Add the subfield “Mode Supported” to the parent field “capability_reg” with

length 4, type CFGREG_RO, a tooltip in the Capability View, and a combo box displaying “mode encodings” for input in the Field View.

12.5 Helper File

ConfigSpaceCommon.inc include file contains useful functions for script decoding.

Appendix B

Example of XML File Format for SSD Decodes

```
<DEVICES XML_FORMAT_VERSION="1.0">
<DEVICE ENABLE="0x1" VENDORID="0" CLASSCODE="67586" GUID="{9C9654A1-B693-4F30-912F-
                    125059814C42}" DEVICEID="000:00:0">
<BARS>
<MBAR ID="0" VALUE="0xF0000000"/>
<BAR ID="2" VALUE="0x00000000"/>
<BAR ID="3" VALUE="0x00000000"/>
<BAR ID="4" VALUE="0x00000000"/>
<BAR ID="5" VALUE="0x00000000"/>
</BARS>
<PROTOCOL ASQS="64" DSTRD="4" ACQS="16" LBASIZE="512" PROTOCOL="NVME" MPS="4096"
  ADDEDBY="DECODING"/>
<Queues>
<Queue SIZE="10" QID="2" TYPE="IOSQ" ADDRESS="0x11B210300" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="3" TYPE="IOSQ" ADDRESS="0x11B210340" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="5" TYPE="IOSQ" ADDRESS="0x11B210380" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="7" TYPE="IOSQ" ADDRESS="0x11B2103C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="9" TYPE="IOSQ" ADDRESS="0x11B210400" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="11" TYPE="IOSQ" ADDRESS="0x11B210E80" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="14" TYPE="IOSQ" ADDRESS="0x11B210E40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOSQ" ADDRESS="0x11B210E00" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="6" TYPE="IOSQ" ADDRESS="0x11B233040" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="8" TYPE="IOSQ" ADDRESS="0x11B233080" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="10" TYPE="IOSQ" ADDRESS="0x11B233B40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="12" TYPE="IOSQ" ADDRESS="0x11B233B00" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="13" TYPE="IOSQ" ADDRESS="0x11B233AC0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOSQ" ADDRESS="0x11B233A80" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="17" TYPE="IOSQ" ADDRESS="0x11B233A40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOSQ" ADDRESS="0x11B25F080" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOSQ" ADDRESS="0x11B28B040" ADDEDBY="DECODING"/>
```

<Queue SIZE="10" QID="3" TYPE="IOCQ" ADDRESS="0x11B2200C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="5" TYPE="IOCQ" ADDRESS="0x11B2200E0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="7" TYPE="IOCQ" ADDRESS="0x11B2200F0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="9" TYPE="IOCQ" ADDRESS="0x11B220100" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="11" TYPE="IOCQ" ADDRESS="0x11B2203A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="14" TYPE="IOCQ" ADDRESS="0x11B220390" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B220380" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="6" TYPE="IOCQ" ADDRESS="0x11B243010" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="8" TYPE="IOCQ" ADDRESS="0x11B243020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="10" TYPE="IOCQ" ADDRESS="0x11B2432D0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="12" TYPE="IOCQ" ADDRESS="0x11B2432C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="13" TYPE="IOCQ" ADDRESS="0x11B2432B0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOCQ" ADDRESS="0x11B2432A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B243290" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOCQ" ADDRESS="0x11B26F020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="2" TYPE="IOCQ" ADDRESS="0x11B26F030" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOCQ" ADDRESS="0x11B29B010" ADDEDBY="DECODING"/>
</Queues>
</DEVICE>
</DEVICES>

Appendix C

China Restriction of Hazardous Substances Table

The following tables are supplied in compliance with China's Restriction of Hazardous Substances (China RoHS) requirements:

	有毒有害物质和元素					
部件名称	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{6+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCBAs	X	O	X	X	X	X
机械硬件	O	O	X	O	O	O
金属片	O	O	X	O	O	O
塑料部件	O	O	O	O	X	X
电源	X	X	X	O	X	X
电源线	X	O	X	O	X	X
保护外壳(如有)	O	O	O	O	X	X
电缆组件(如有)	X	O	X	O	X	X
风扇(如有)	X	O	X	O	X	X
交流滤波器和熔丝组件(如有)	X	O	X	O	O	O
外部电源(如有)	X	X	X	O	X	X
探头(如有)	X	O	X	O	X	X
O: 表明该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求之下。						
X: 表明该有毒有害物质至少在该部件的某一均质材料中的含量超过 SJ/T11363-2006 标准规定的限量要求。						

EFUP (对环境友好的使用时间) 使用条件：参阅本手册“规范”部分规定的环境条件。

	Toxic or Hazardous Substances and Elements					
Part Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr^{6+})	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
PCBAs	X	O	X	X	X	X
Mechanical Hardware	O	O	X	O	O	O
Sheet Metal	O	O	X	O	O	O
Plastic Parts	O	O	O	O	X	X
Power Supply	X	X	X	O	X	X
Power Cord	X	O	X	O	X	X
Protective Case (if present)	O	O	O	O	X	X
Cable Assemblies (if present)	X	O	X	O	X	X
Fans (if present)	X	O	X	O	X	X
AC Filter/Fuse Assy (if present)	X	O	X	O	O	O
Ext Power Supply (if present)	X	X	X	O	X	X
Probes (if present)	X	O	X	O	X	X
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement specified in SJ/T11363-2006.						
X: Indicates that this toxic or hazardous substance contained in at least one of the homogenous materials used for this part is above the limit requirement specified in SJ/T11363-2006.						

EFUP (Environmental Friendly Use Period) Use Conditions: refer to the environmental conditions stated in the specifications section of this Manual.

Appendix D

How to Contact Teledyne LeCroy

Type of Service	Contact
Call for technical support	US and Canada: 1 (800) 909-7112 Worldwide: 1 (408) 653-1260
Fax your questions	Worldwide: 1 (408) 727-6622
Write a letter	Teledyne LeCroy Protocol Solutions Group Customer Support 3385 Scott Blvd. Santa Clara, CA 95054-3115 USA
Send e-mail	psgsupport@teledynelecroy.com
Visit Teledyne LeCroy's web site	teledynelecroy.com
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail by selecting **Help>Tell Teledyne LeCroy** from the application toolbar. This requires that an e-mail client be installed and configured on the host machine.

Index

Symbols

.lic files 285
.opt files 189
.peraw file extension 205
.pex files 44, 45
.rec files 44
+ Packet # button 183
+ sign 198

Numerics

10b errors 197
10-bit code format 193

A

Actions Properties Dialog 90
Activity 40
Adding an Attachment 156
address 295
Advanced Hiding Options 22
AHCI level decode 146
All Connected Devices 49
All Markers Window 163
Analyzer
  license 285
  update 285
analyzer
  testing 42
Analyzer Network Chat Bar command 49
application 7
ATA level decode 147
Attaching Markers 156
Auto De-Skew command 193
Auto Run 7
Auto-Configure Lane Polarity 64
Available Events area 70
  68
averaging 246

B

Bandwidth 259
Base Spec 1.0 Rev Compatibility Mode 62
Basic Resource 74
Beep When Trigger Occurs 59
Binary code format 193
Bit Tracer mode 3
BitTracer
  color-coding 194
  compressing data view 205
  data capture mode 191
  data display 193
  Data Display toolbar. 193
  decoding 200
  de-skewing 192
  enabling 191
  Errors window 197
  expanding data view 205
  exporting 204
  link configuration 202
  logical links 204
  markers 195
  recording mode 191
  report windows 194
  saving 205
  search 201
  Symbol window 198
  timing 195
  Timing window 196
  views 192
  zooming 205
BitTracer Recording 60
blue current-position indicator 234
Both directions 236
Buffer Size 58
Bus Utilization 216, 259
  buttons 220
  features 246
  metrics 245
  pop-up menu 217
BusEngine update 285

C

calculating time between DWORDs 225

CATC Technical Support 295
CATC Trace 2
CATC Trace View 130
CATC Walk Playlist 165
cells 122
  resizing 122
  states 77
Change Counter Value command 113
changing
  markers 129
Changing the Value of the Counter 109
Changing the Value of the Timer 113
Channel 114
Channels 83
Chat session 49
Chat window 49
Clear Marker command 129
Clocks radio button 152
Collapse Idle 227
Collapse Idle Plus. 227
Collapsible Idle Time 224
collapsing 121
Color Format Hiding tab 182
Color pop-up menu 184
colors 183
Combining Specified Event Groups 171
Combo box 240
Comma Separated Value files 47
Comment field 128
comment string 127
CompeterID field 239
components 5
Compressed CATC Trace 129
Configuration Space 239
Configuration Space dialog box 239
Configuration Space Header 240
Configuration Space View 239
configuring
  Recording Options 42
connecting 12, 14, 15
contact 295
Continue option 43
Continuous Time Scale 227
controls
  Analyzer T24 5
Count action 72
CrossSync Control Panel 4, 30
CSV files 47
current-position indicator 234

D

Data Block window 122
data cells 122
Data Field 121
Data Flow command 227
Data Flow window 227
Data Throughput 241, 259
data.pex file 44
decode levels 135
decoding 135
Decoding window 200
default options file 56
default.opt file 189
default.rec file 56
Defining Recording Rules 69
Deleting a Counter 110
Deleting a Timer 114
delimiters 234
descrambled format 193
Description String 83
descriptive label 57
Detail View and Spreadsheet View 134
DeviceID field 239
Direction field 171
Disable Descrambling 63
disparity errors 197
Display area 18
Display Configuration Name 182
Display License Information command 285
Display Options 181
  command 181
  dialog box 181
  fFiles 44
  loading 189
  saving 189
Display Options button 181
DLLP Packet Properties dialog 85
Do not save hidden packets option 46
Downstream 63
Downstream direction 236
Downstream Symbol 60
Drag an event here to create a new sequence 79
DVD-ROM 7
DWORDs
  timing 225

E

Edit Comment command 49
Edit Marker 162
Edit Marker command 129
Edit Marker for Packet # pop-up 128
e-mail 295
Email CATC Support 295
Empty Trace Warning Message 182

Enable Tool tips 182
Error Properties dialog box 84
Error Summary dialog box 209
error types 84
errors
  10b 197
  disparity 197
Errors pane 233
Errors window 197
Event Groups menu 170
Event Icon Preview 82
Event Navigation 216
Event Trigger recording type 58
events
  searching 151
Events report window 198
Event-specific Settings 83
Exclude option 171
Expand Data command 121
Export command
  BitTracer 204
Export to Compressed Archive command 205
exporting 47

F

fax number 295
field
  hiding 186
Field Colors tab 183
Field Formats tab 185
file formats 47
File Menu 24
filter 92
Filter action 72
Filter In button 93
Filter Out button 93
Find command 169
Find dialog box 170
Find Next command 176
finding 170
Firmware update 285
First, Prev, Next, and Last buttons 240
Fit to Graph Area 218, 251
Flush option 43
Fonts 182
format
  field 185
From packet # field 48
From Packet field 46
front panel 5
Functionality of Markers 154

G

Gen2 PCI Express 16-lane advanced verification system 1
General tab 53, 181
Generator file format 47
Global State 77
Global State and Sequence States 77
Global State Cell 71
Go To Marker command 153
Go to Marker command 225
Go To menu 168
Go to Packet # 218
Go to Packet command 152
Go to Trigger command 151
Grid Lines 216
Group and Colors column 184, 185

H

header fields 124
Help Menu 37
Hexadecimal vs. Binary tabs 240
Hide 218, 251
Hide buttons 21, 226
Hide Downstream button 22
Hide SKIP and Update FC button 22
Hide Training button 22
Hide Upstream button 22
hiding 186, 187
  Idles 226
Hiding tab 186
Hierarchy Lines 182
host machine requirements 5
How to Increment or Reset a Counter 108
How to Set a Counter 108
How to Set a Timer 112
How to Start or Reset a Timer 112

I

Icon Label 83
Idle errors 84
Ignore Idle Errors 64
information
  priority 235
InitFC complete status 253
Install component selection 7
interface 7
Interposer 11
interposer
  installing 11
Intersection option 171

K
K/D symbol format 193
Key
License 285
keyboard shortcuts 39
keystrokes 39

L
label 57
Latency 259
Latency Time 241
Launching the CrossSync Control Panel 50
layout 18
LeCroy PCIe Protocol Suite command 7
LEDs
Analyzer T24 5
Legend option 234
level hiding 187
Level Hiding tab 186
levels 135
LFSR value 194
license files 285
License Information window 285
License Key 285
licensing information 285
Linear 218, 251
Link Configuration dialog 202
Link level decode 136
Link section 43, 61
Link Settings 61
Link State 253
Link State Dialog 83
Link Tracker
buttons 226
toolbar 223
Link Tracker window 222
docking 225
markers 225
reformat 223
link training 43
Link Transaction
metrics 244
Link Transaction Level graphs 247
Link Transaction Performance 244
Link Utilization 259
Link Width 62, 63
Link Width pane 233
Load 120
Load button 56, 189
Load command 56, 189
loading 56, 189
Logarithmic 218, 251
logical links
BitTracer 204
Logical view 200
long format 121
LTSSM Flow Graph 236
LTSSM Flow Graph command 236

M
Main Display Area 223
Main display area 68
Manual Trigger
recording type 58
Markers 153
Adding an Attachment 156
Attachment Types and Visualization 157
Embedded Attachments to a Marker 157
Recording an Audio File 157
Video Files supported 157
markers 127
BitTracer 195
deleting 129
editing 129
setting 127, 225
user-defined 196
Markers Overview 153
Markers window 196
Memory Writes 244
Memory Writes Performance 259
Menu bar 18
menus 24
pop-up 122
metrics 240
Bus Utilization 245
Link Transaction 244
Link Transactions 241
Split Transaction 243
Split Transactions 241
trace 241
Traffic Summary 243
unit-base averaging 246
Metrics Header 242
Metrics Tooltip 242
Microsoft® Windows®-based host machine 7
Misc 59
Msb -> Lsb checkboxes 186

N
navigating 230
Navigating Recording Rules 80
Navigator 230
displaying 230
legend 234
panes 231, 233
range 231, 232
ranges 231
slider 234
toolbar 231
Navigator Legend dialog box 234

Navigator Panes button 234
Navigator Range button 232
New Event button 70
New Events button 82
Number of data packets 253
Number of Link Transactions 241
Number of Packets 241
NVMe level decode 137
NVMe PCIe SSD Device Configuration 261

O

opening
  program 8
options files 56
Options Name 56
Options Name box 57
Ordered Set Properties Dialog 84
Origin field 171

P

Packet # 183
Packet # field 127
Packet Data command 238
Packet Data window 238
Packet Directionality Cell 127
Packet errors 84
Packet Header bar 237
Packet Header Cell 127
Packet Header command 237
Packet Heading Cell 125
Packet level decode 135
Packets report window 199
Packets/second 259
pane checkbox 235
Pattern Format section 202
Payload 241
Payload size 253
PCI Express 16-lane advanced verification system 1
PCIe Protocol Suite SN message 40
PCIe Protocol Suite Summit
  components 12, 14, 15
PCIe Protocol Suite T24
  opening 8
PHY layer problems 3
Pin Button 83
Playback Window 166
Playlist Functionality 165
Playlist Playback Control 167, 168
plus symbol 184, 185
polarity checkbox 203
pop-up menus 122
Power Switch 5
powering on 11
PQI level decode 149
PQI PCIe SSD Device Configuration 266
Pre/Post Trigger pane 233
Preserve TC to VC mapping across the channels 59
Print command 48
Printer button 48
printing 48
Probe Settings 115
program
  opening 8
Properties 218, 252
Properties button 82
Properties command 71
Properties dialog 82
Properties dialog box 71, 82
Protocol Level to View 182
protocol unit 240

R

range delimiters 234
Raw 10b Codes 123
Read Requests Performance 243
reading 121
Ready message 40
Real-Time Statistical Monitor window 251
Real-Time Statistics
  buttons 249
  pop-up menu 251
  toolbar 249
Real-Time Statistics window 248
Real-time Statistics window 252
rear panel 6
Recently Used Ranges 233
Record button 43
Record Menu 30
recorded activity 41
recording 42, 53
  stopping 43
Recording button 72
Recording Mode 60
Recording Options
  command 53
  configuring 42
  dialog box 53
  files 44
  loading 56
  saving 56
  settings 57
Recording Options command 42
recording progress 40
Recording Progress Bar 40
Recording Rules

buttons 69
toolbar 69
Recording Rules Events 80
recording status 41
Recording Type 57
Reference Clock 63
Remove 218
Report Menu 31
Report menu 207
reports 207
Reset Column Widths 225
resizing 122
Response Time 241, 259
Retain Decoded Files 182
Row Selection 216
Run verification scripts command 270
Running Disparity 193

S

Save 119
Save As command 45
Save As Default 56, 189
Save As Default. 56
Save button 189
Save External Interface Signals 59
Save packet range command 46
saving 45, 189
BitTracer 205
scrambled format 193
SCSI level decode 150
Search 40
command 151
Search Bwd message 169
search direction 42
Search Direction command 169
Search For menu 170
Search Fwd message 169
Search Menu 32
Search On section 202
Search Order section 202
Search Pattern window 202
Search window
BitTracer 201
searching 151
Seconds radio button 152
selecting components for installation 7
Send command 50
Sequence Cell 71
Sequence State 73, 74, 76, 77, 78, 79
Set Display Options command 183
Set Marker command 128, 225
Set Marker with Text command 196
Set Range Near Packet xxx 233
Set Range to Whole Trace 232
Setting Auto Calibration 115
setting markers 127
Settings button 271
Settings window 271
Setup command 7
Setup Menu 30
short format 121
shortcuts 39
Show Configuration Space for xxxx 239
Show Header Fields command 124
Show Header Fields dialog box 124
Show Number of Transitions checkbox 236
Show Packet in Raw Trace 204
Show Raw 10b Codes command 123
small triangle 121
software 17
update 285
SOP and SCSI PCIe SSD Device Configuration 269
SOP level decode 150
Specification view 200
Specify Action command 71
Split level decode 136
Split Transaction
metrics 243
Split Transaction Level graphs 246
Split Transaction Performance 243, 259
Spreadsheet View 130
StandardSettings.rec file 56
Start menu 7
Statistics Accumulation area 252
Status Bar 40
Status bar 18
Stop button 43
Stop option 43
stopping recording 43
Summit T2-16 front panel 5
Summit T3-16 1, 2, 5
support 295
Swap Recording Channels 62
Swizzling Config... 64
Symbol window 198
Synchronize Trace View 226

T

Technical Support 295
telephone number 295
testing 42
text files 47
Throughput 259, 260

Tight Columns 216
time between DWORDs 225
Time Coverage 259
Time Stamp 182
time value 225
time-based averaging 246
Timestamp at the beginning 182
Timing and Bus Usage Calculator 256
Timing Calculations command 255, 256
Timing Calculator dialog box 256
Timing measurement
  BitTracer 195
Timing window 196
Title bar 18
TLP Header Properties dialog box 86
TLP Prefix Properties Dialog 86
To packet # field 48
To Packet field 46
Tool tip Display 224
Toolbar 18, 68
Tools Menu 36
Tools menu 207
Tooltips 39
trace
  cells 122
  exporting 47
  files 44
  metrics 241
  saving 45
Trace Filename and Path 55
Trace View Mode 182
Trace Viewer 8
traces
  searching 151
traffic 121
  analyzing 207
Traffic Speed pane 233
Traffic Summary
  buttons 216
  metrics 243
Traffic Summary window 213
  moving to packets 214
Traffic Type pane 233
triangle 121
Trigger action 71
Trigger marker 195
Trigger Position 60
Triggering 65
Triggering On (Advanced Mode) 67
Triggering On (Simple Mode) 66

U

Undo Zoom 218, 251
Union option 171
unit 240
unit-based averaging 246
Update Analyzer dialog 285
Update command 285
Update Device command 285
Update License dialog box 285
updates 285
Upload Size 59
Uploading 40
Upstream 63
Upstream direction 236
Upstream Symbol 60
user-defined markers 196

V

Verification Script dialog box 270
View Data Block command 122, 123
View Menu 35
View Options 226
View Options button 224
View Settings 220
Viewer 8
Viewing Attachments of a Marker 158

W

web site 295
Website, CATC 295
Window Menu 37
Wrap 182
Write Requests Performance 243
Writes Response Time 247
Writes Throughput 247

X

X marker 195
x16 Slot Interposer 11

Y

Y marker 196
Y Scale Type 218, 251
yellow range delimiters 234

Z

zoom 224
Zoom Level 182
Zoom to Trace View 218